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Technical Memorandum
Alternatives Screening

Pines Area of Investigation
AOC II
Docket No. V-W-’04-C-784

Submitted by:
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Chelmsford, MA
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Disclaimer

This document is a document prepared under a federal administrative order on consent.

The first four chapters of this document were provided to the United States Environmental Protection Agency (USEPA) in the Remedial Action Objectives Technical Memorandum in January 2012. USEPA provided comments on these chapters in a letter dated April 18, 2012.

The last two chapters of this document were provided to the USEPA in the Alternatives Screening Memorandum in June 2012.

USEPA provided comments on all chapters in a letter dated August 31, 2012. All chapters have been revised per the responses to comments, which are provided in Appendix A.

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List of Acronyms

AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirement
AUF	Area Use Factor
BERA	Baseline Ecological Risk Assessment
BTV	Background Threshold Value
bgs	below ground surface
CCB	Coal Combustion By-product
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cfs	cubic foot per second
CMC	Criterion Maximum Concentration
COC	Constituent of Concern
COPC	Constituent of Potential Concern
COPEC	Constituent of Potential Ecological Concern
CSM	Conceptual Site Model
CTE	Central Tendency Exposure
DO	Dissolved Oxygen
EPC	Exposure Point Concentration
EPRI	Electric Power Research Institute
ERA	Ecological Risk Assessment
ESV	Ecological Screening Value
FS	Feasibility Study
GQS	Groundwater Quality Standard
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
IDEM	Indiana Department of Environmental Management
IDNL	Indiana Dunes National Lakeshore
LOAEL	Lowest Observed Adverse Effect Level
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
mg/L	Milligram per Liter
MWSE	Municipal Water Service Extension
NCP	National Contingency Plan
NIPSCO	Northern Indiana Public Service Company
NOAEL	No Observed Adverse Effect Level
OSWER	Office of Solid Waste and Emergency Response
pCi/g	PicoCurie per Gram
RAL	Removal Action Level
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose

RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RISC	(State of Indiana's) Risk Integrated System of Closure
RME	Reasonable Maximum Exposure
RSL	Regional Screening Level
ROW	Right-of-Way
SAB	Scientific Advisory Board
SAP	Sampling and Analysis Plan
SDWA	Safe Drinking Water Act
SERA	Screening-Level Ecological Risk Assessment
SMC	Secondary Maximum Concentration
SMDP	Scientific/Management Decision Point
SMS	Site Management Strategy
SOW	Statement of Work
SWQS	Surface Water Quality Standards
TBC	To Be Considered
TOC	Total Organic Carbon
TRV	Toxicity Reference Value
TSS	Total Suspended Solids
ug/L	micrograms per liter
UCL	Upper Confidence Limit
UMTRCA	Uranium Mill Tailings Radiation Control Act
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WQC	Water Quality Criteria

Standard Chemical Abbreviations

Al	Aluminum
As	Arsenic
B	Boron
Ba	Barium
Cd	Cadmium
Ca	Calcium
Cl	Chlorine
Co	Cobalt
Cr	Chromium
Cr (VI)	Hexavalent Chromium
Cu	Copper
Fe	Iron
Hg	Mercury
HCO_3	Bicarbonate
K	Potassium
Mn	Manganese
Mg	Magnesium
Mo	Molybdenum
Na	Sodium
Ni	Nickel
NO_3	Nitrate
NH_4	Ammonia
Pb	Lead
Po	Polonium
Ra	Radium
S	Sulfur
Se	Selenium
Si	Silicon
SO_4	Sulfate
Sr	Strontium
Tl	Thallium
Th	Thorium
U	Uranium
V	Vanadium
Zn	Zinc

1.0 Introduction

In April 2004, the United States Environmental Protection Agency (USEPA) and the Respondents (Brown Inc., Ddalt Corp., Bulk Transport Corp., and Northern Indiana Public Service Company (NIPSCO)) signed an Administrative Order on Consent (AOC II) (Docket No. V-W-'04-C-784) to conduct a Remedial Investigation and Feasibility Study (RI/FS) at the Pines Area of Investigation, located in the environs of the Town of Pines, Indiana, as set forth in Exhibit I to AOC II (AOC II, 2004). AOC II (Section VII. 22) and its attachment, the Statement of Work (SOW) (Tasks 6 and 7), require the Respondents to identify remedial action objectives (RAOs) and develop and evaluate a range of appropriate remedial options that meet the RAOs for the Pines Area of Investigation. A Technical Memorandum summarizing the RAOs for the Area of Investigation was submitted to the USEPA in January 2012 (AECOM, 2012a), and USEPA comments on that memorandum were received on April 18, 2012. Responses to USEPA comments are provided as Appendix A1, and are incorporated into that document as required. A Technical Memorandum summarizing the development and screening of remedial alternatives in accordance with AOC II and Task 7 of the SOW was submitted to the USEPA in June 2012 (AECOM, 2012b), and USEPA comments on that memorandum were received on August 31, 2012. Responses to USEPA comments are provided as Appendix A2, and are incorporated into this revised Alternatives Screening Technical Memorandum.

The remainder of this section provides a brief description of the Pines Area of Investigation (Section 1.1) and the historical background of the project (Section 1.2), a description of the Feasibility Study (FS) process for the Area of Investigation per AOC II (Section 1.3), a review of USEPA and other guidance documents used to prepare this Technical Memorandum (Section 1.4), and a summary of the remaining sections of this Memorandum (Section 1.5).

1.1 Description of the Pines Area of Investigation

The Pines Area of Investigation is located immediately west of the city limits of Michigan City, Indiana, and about 4,500 feet south of the southern shore of Lake Michigan (see Figure 1). The area is located primarily in the Town of Pines, in Porter County, Indiana, and encompasses approximately 1,450 acres (2.3 square miles). The Indiana Dunes National Lakeshore (IDNL), managed by the National Park Service, is located between Lake Michigan and the Town of Pines; a small portion of the IDNL is included within the Area of Investigation.

The Area of Investigation is sectioned in the east-west direction by two major roadways, US Route 12 (West Dunes Highway) in the northern portion, and US Highway 20 in the central portion. An east-west railroad bisects the central portion of the Area of Investigation. A major utility corridor runs parallel and just to the north of US Route 12. The IDNL comprises the portion of the Area of Investigation north of the utility corridor. Both residential and commercial establishments are located along US Route 12, and the area just south of US Route 12 consists mainly of single-family homes, located mainly along the uplands of the dune-beach complex topography that characterizes this area of northern Indiana. South of the residential areas, and north of the railroad are wetlands characteristic of the swale topography. These wetlands are now drained by the east and west branches of the man-made Brown Ditch, which was constructed to improve drainage and prevent flooding in the area. The confluence of the east and west branches of Brown Ditch is located approximately in the center of the Area of Investigation, where Brown Ditch then flows north into the

IDNL (Figure 2). Within the IDNL the ditch takes a turn due east and flows into Kintzele Ditch, which then flows to Lake Michigan.

The Area of Investigation contains residential areas, the majority of which are located between US Route 12 and US Highway 20. Additional residences are located mainly along Ardendale, Railroad Avenue, and Old Chicago Road. Each house historically may have had its own drinking water well or septic system or both. Figure 3 shows the portion of the Area of Investigation that has been provided municipal water service in accordance with AOC I (2003) and the Amendment to AOC I (2004). It is expected that septic systems will continue to be used in this community (i.e., there is no municipal sewage system).

Yard 520, a closed Restricted Waste Facility permitted by the Indiana Department of Environmental Management (IDEM), is located in the western portion of the Area of Investigation, between US Route 20 to the north and Brown Ditch and the railroad to the south. Yard 520 was previously used for the disposal of coal combustion by-products (CCBs) primarily from NIPSCO's Michigan City Generating Station, and was closed between 2004 and 2007. Two former dump sites, the Pines Landfill (owned by Waste Management) and the Lawrence Dump are located in the area to the south of Yard 520 and the railroad and north of Old Chicago Road (Figure 2).

In addition to the CCBs disposed of at Yard 520, suspected CCBs have also been observed in roadbed and other areas in certain portions of the Area of Investigation. Figure 4 depicts the information compiled about the potential locations of CCBs at the ground surface within the Area of Investigation, based on the information presented in the Remedial Investigation (RI) Report (AECOM, 2010).

1.2 Historical Background and Previous Remedial Actions

Between 2000 and 2004, IDEM and USEPA conducted sampling of private wells in a portion of the Town of Pines. Boron (B) and molybdenum (Mo) were detected in some samples at concentrations above USEPA Removal Action Levels (RALs) (USEPA, 1998). USEPA suspected that these concentrations above USEPA RALs were derived from CCBs because CCBs were disposed of in Yard 520 and CCBs were reported to have been used as fill in areas within the Area of Investigation outside of Yard 520.

To address the B and Mo detections above the USEPA RALs, the Respondents agreed to extend Michigan City's municipal water service from Michigan City to designated areas in the Town of Pines. This agreement was documented in an Administrative Order on Consent, referred to as AOC I, dated February 2003 (AOC 1, 2003). Subsequent sampling of additional private wells within the Area of Investigation indicated some concentrations near or exceeding these RALs. To address these exceedances, the Respondents approached the USEPA about extending the municipal water service to a larger area, under the AOC I, amended, dated April 2004 (AOC 1, 2003). The areas that received municipal water service are identified and shown in Figure 3. In all, the Respondents provided municipal water to more than 290 residences and businesses in this area. In addition to extending the municipal water service, AOC I (amended) includes a provision to offer bottled water to those residences within the Area of Investigation not connected to municipal water. The cost for this remedial action is $5,255,000, including the provision of bottled water to residents outside of the MWSE area who have requested this service to date. Note that the Respondents voluntarily chose to provide the extended municipal water service identified under the Amendment to AOC I, and that this response occurred well in advance of the conclusion of the RI/FS process.

Yard 520 was closed between 2004 and 2007, and the cost for this remedy was $1,524,000.

Concurrently with AOC I, amended, USEPA and the Respondents entered into a second AOC, referred to as AOC II (AOC II, 2004). Under AOC II, the Respondents committed to conduct an RI/FS for the Area of Investigation.

1.3 RI/FS Process for the Pines Area of Investigation

The objectives of the RI/FS, as stated in AOC II, include:

> (a) to determine the nature and extent of contamination at the Site and any threat to the public health, welfare, or the environment caused by the release or threatened release of hazardous substances, pollutants or contaminants related to coal combustion by-products ("CCB") at or from the Site.
>
> (b) to collect data necessary to adequately characterize…(i) whether the water service extension installed pursuant to AOC I and AOC I as amended is sufficiently protective of current and reasonable future drinking water use of groundwater in accordance with Federal, State, and local requirements, (ii) any additional human health risks at the [Area of Investigation] associated with exposure to CCBs; and (iii) whether CCB-derived constituents may be causing unacceptable risks to ecological receptors; and,
>
> (c) to determine and evaluate alternatives for remedial action to prevent, mitigate, control or eliminate risks posed by any release or threatened release of hazardous substances, pollutants, or contaminants related to CCBs at or from the Site, by conducting a Feasibility Study.

Thus, AOC II recognizes that a major response action was conducted under AOC I, and that one objective of the remaining investigation was to determine if this response was sufficiently protective, or if additional response actions should be considered.

Performance of these objectives is accomplished through ten (10) tasks, as described in Part VII of AOC II (Work to be Performed). Tasks 1 through 5 have been completed, and are documented in the following reports:

- Site Management Strategy (SMS) (ENSR, 2005a): This document summarized the available information about the geology and hydrogeology of the area and the historical placement of CCBs within the Area of Investigation, presented a preliminary conceptual model, identified data gaps, and outlined the general approach to the RI/FS.
- RI/FS Work Plan, Volumes 1-7. (ENSR, 2005c).
- Additional sampling work plans for the RI Field Investigation, including the Municipal Water Service Extension (MWSE) Sampling and Analysis Plan (SAP) (ENSR, 2004), and the Yard 520 SAP (ENSR, 2005d).
- RI Report (AECOM, 2010): this report documents the results of the RI conducted at the Pines Area of Investigation in accordance with AOC II. This report provides the results of the RI Field Investigation activities and a conceptual site model for the CCB-derived constituents in environmental media at the Area of Investigation.
- Human Health Risk Assessment (HHRA) (AECOM, 2011a) and Screening-Level Ecological Risk Assessment (SERA) (AECOM, 2011b).

Task 6 is Identification of RAOs. This task states that the Respondents shall submit a RAO Technical Memorandum consistent with the SOW, and based on the results of the HHRA and SERA. This Memorandum was submitted to the USEPA in January 2012 (AECOM, 2012a), and identified RAOs specific to the Pines Area of Investigation considering the following (AOC II SOW):

- Prevention or abatement of unacceptable risks (current and/or reasonable future) to nearby human populations (including workers), animals, or the food chain from hazardous substances, pollutants, or constituents associated with CCBs.
- Prevention or abatement of unacceptable risks (current and/or reasonable future) associated with CCBs due to exposures including drinking water supplies and ecosystems.
- Acceptable constituent levels, or range of levels, for appropriate site-specific exposure routes.
- Mitigation or abatement of other situations or factors that may pose threats to public health, welfare, or the environment.
- A preliminary evaluation of Applicable or Relevant and Appropriate Requirements (ARARs).

USEPA provided comments on the RAO Technical Memorandum on April 18, 2012. Responses to these comments are provided in Appendix A1. Revisions to the text were made as required in the Alternatives Screening Technical Memorandum.

The Alternatives Screening Technical Memorandum was submitted to the USEPA in June 2012 (AECOM, 2012b), as required under Task 7. In this Memorandum, potential remedial alternatives that address the established RAOs were presented and summarized. The memorandum also identified and assessed a limited number of alternatives appropriate for addressing the RAOs. Per AOC II, the Alternatives Screening Memorandum included descriptions of technologies that were eliminated from consideration, including the basis for such elimination. Preliminary screening was based on permanence, effectiveness, implementability, and order of magnitude cost. The outcome of the Alternatives Screening was a short list of alternatives that will undergo detailed analysis in the FS.

USEPA approved and provided comments on the Alternatives Screening Memorandum on August 31, 2012. The memorandum has been revised per the responses to these comments, which are provided in Appendix A2.

Task 8 is the FS. The FS will include a detailed analysis of the alternatives that represent viable approaches to remedial action within the Pines Area of Investigation. The detailed analysis will consist of an assessment of individual alternatives relative to nine evaluation criteria set forth in 40 CFR 300.43(e)(9)(iii), and a comparative analysis that focuses upon the relative performance of each alternative against those criteria.

1.4 USEPA and Other Guidance Used to Conduct the FS

Per the SOW, the RI/FS is conducted consistent with the Guidance for Conducting Remedial Investigations and Feasibility Studies under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (USEPA, 1988) and additional appropriate USEPA guidance. Thus, the identification of RAOs has been conducted consistent with the RI/FS guidance and the following Office of Solid Waste and Emergency Response (OSWER) directives:

- USEPA, 1989b. A Guide on Remedial Actions for Contaminated Ground Water. OSWER 9283.1-1FS, April.
- USEPA, 1992. Considerations in Ground-Water Remediation at Superfund Sites and RCRA [Resource Conservation and Recovery Act] Facilities – Update. OSWER 9283.1-06, May.

- USEPA, 1996. Ground Water Cleanup at Superfund Sites. EPA 540-K-96 008, December.
- USEPA, 1997. Implementing Presumptive Remedies. EPA 540-R-97-029, October.
- USEPA, 1999. A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents. EPA 540-R-98-031, July.

1.5 Report Organization

The remaining sections of this Technical Memorandum provide the following in support of developing RAOs and remedial alternatives for the Pines Area of Investigation:

- Section 2.0 provides a summary of the RI, HHRA and SERA Reports relative to the information necessary to develop RAOs;
- Section 3.0 provides a preliminary evaluation of ARARs;
- Section 4.0 identifies the RAOs;
- Section 5.0 identifies general response actions and areas within the Area of Investigation to which the general response actions apply;
- Section 6.0 provides the alternatives screening documentation, including identifying and screening remedial technologies, and assembling and screening remedial alternatives; and
- Section 7.0 provides references cited in this Memorandum.

2.0 Summary of the Remedial Investigation, Human Health Risk Assessment, and Ecological Risk Assessment

This section presents a summary of the RI (AECOM, 2010), HHRA (AECOM, 2011a) and the SERA (AECOM, 2011b), in particular concentrating on the portions of those Reports that are relevant to identifying RAOs for the Pines Area of Investigation.

2.1 Setting of the Pines Area of Investigation

Characteristics of the Pines Area of Investigation that are relevant to this Technical Memorandum include Geology and Hydrogeology, Surface Water, and Suspected CCBs.

2.1.1 Geology and Hydrogeology

Groundwater is present beneath the Area of Investigation in the shallow surficial aquifer made up primarily of wind-blown sands associated with the current and former shores of Lake Michigan. The base of the surficial aquifer is formed by a clay confining unit. The surficial aquifer is thickest beneath upland dune areas, is thinner beneath low-lying wetlands areas between the dunes (such as the Great Marsh in the IDNL), and pinches out completely to the south against the silts and clays of the Valparaiso Moraine and/or lacustrine sediments of Glacial Lake Chicago. A geologic cross-section is shown in Figure 5. Regionally, groundwater is also present in deeper, confined aquifers in the area, but the RI demonstrated that these could not be impacted by CCB-related constituents; therefore, the RI focused primarily on groundwater in the shallow, surficial aquifer.

Groundwater characteristics and behavior in the Area of Investigation shallow, surficial aquifer are straightforward and are typical of such aquifers. Groundwater occurs as a water table aquifer (in the surficial aquifer) at depths ranging from near the ground surface (in wetland areas) to approximately 25 feet beneath upland dune areas. Groundwater flow is generally from the upland areas to Brown Ditch and its tributaries and wetlands located in the low-lying areas, including within the IDNL. In general, during both wet and dry periods, groundwater discharges to the Brown Ditch system (including associated tributaries and wetlands) throughout the Area of Investigation. A groundwater contour map is shown on Figure 6. While there might be a few instances where this gradient is reversed, these conditions are short-term and local, and do not affect the overall groundwater flow.

Seasonally, groundwater levels fluctuate approximately one to two feet, with water levels lower in the summer and fall (growing season) and higher in the winter and spring. Based on data collected during the RI, the hydraulic gradients and directions of groundwater flow do not change seasonally.

The hydraulic conductivity of the surficial aquifer was tested during the RI (slug testing) with estimated values ranging from approximately 5 to 50 feet/day with a geometric mean of 14.7 feet/day, consistent with the fine sands of the surficial aquifer. An average linear groundwater velocity of approximately 0.5 feet/day was calculated.

2.1.2 Surface Water

The Brown Ditch system is defined as the main branches of Brown Ditch, its associated tributaries and wetlands, including portions located within the IDNL, and makes up the low-lying wetland areas located both north and south of the Town of Pines. The system includes man-made ditches (e.g., Brown Ditch itself), excavated more than 100 years ago to provide drainage in these areas where the water table is shallow. Brown Ditch is a low-gradient channel with low surface water flow volumes and velocities. As measured during the RI, surface water flow rates range from less than one cubic foot per second (cfs) to more than five cfs. Flow rates vary in different branches of the ditch system and are generally higher in the winter and spring and lower in the summer.

2.1.3 CCBs and Suspected CCBs

There are three types of CCBs relevant to the Area of Investigation, as discussed in the SMS (ENSR, 2005a). Their classification is based on how and when they are generated in the coal combustion process. Bottom ash and boiler slag settle to the bottom of the combustion chamber. Fly ash is also generated in the combustion chamber, but it is lighter and finer than the bottom ash and boiler slag and so is transported in the flue gas and ultimately collected by air emission controls (e.g., electrostatic precipitators or other gas scrubbing systems) (U.S. Geological Survey (USGS), 2001). These residues are considered to be by-products because there are many beneficial re-uses for these materials (USGS, 2001).

CCBs are present in Yard 520, a closed Restricted Waste Facility permitted by IDEM that is located in the western portion of the Area of Investigation, between US Route 20 to the north and Brown Ditch and the railroad to the south. Yard 520 was previously used for the disposal of CCBs primarily from NIPSCO's Michigan City Generating Station, and was closed between 2004 and 2007. Although CCBs are present at Yard 520, direct contact with them is an incomplete exposure pathway as the facility is capped and closed.

Suspected CCBs have also been observed in roadbeds and other areas in certain portions of the Area of Investigation.

It is important to recognize that the CCBs present in Yard 520 and suspected CCBs within the Area of Investigation are not the same materials. The material observed during the water service installation included a large percentage of coarse grained material (larger than silt and clay), and the sidewalls of the trenches stayed upright during the utility work. In contrast, the material in Yard 520 was observed to be predominantly very fine grained, soupy or muddy, and would not stay upright on an open face. Based on descriptions from Brown Inc., the material brought to Yard 520 was a wet slurry which needed draining/dewatering. This material would not have been suitable for fill or road sub-base. The observed differences indicate that the CCB material in Yard 520 is primarily fly ash, while the suspected CCB material in the Town of Pines consists of a larger portion of bottom ash and/or boiler slag. Therefore, the materials have different physical and chemical characteristics. Fly ash generally has higher constituent concentrations than bottom ash or boiler slag (Electric Power Research Institute (EPRI), 2010), and this relationship has been demonstrated in the comparison of the radionuclide and metals data between samples collected from Yard 520 and samples collected during the municipal water service extension.

2.2 Remedial Investigation

The RI was completed in accordance with the USEPA-approved RI/FS Work Plan (ENSR, 2005c), including the Field Sampling Plan (Volume 2) and the Quality Assurance Project Plan (Volume 3). The RI consisted of an extensive field investigation including installation of groundwater monitoring wells; geologic and hydrogeologic studies; sampling and laboratory analysis of groundwater, surface water, sediments, background soils, and suspected CCBs; and evaluation of ecological habitats. The analytical results provide a comprehensive dataset with which to evaluate the nature and occurrence of CCB-derived constituents within the Area of Investigation.

The results of the RI are documented in the RI Report. In addition to providing the results of the RI field investigation activities, the collected data were interpreted to develop a conceptual site model for the CCB-derived constituents in environmental media at the Area of Investigation. The findings of the RI are summarized below.

2.2.1 CCB Visual Inspections

A visual inspection program was developed and conducted as part of the RI. In this program, CCB visual inspections were conducted at over 3,800 "inspection locations" within rights-of-ways (ROWs) and at over 4,600 inspection locations on private property, for a total of over 8,400 inspected locations within the Area of Investigation. The inspection locations evaluated during the visual inspection represent a wide range of areas within the Area of Investigation. Visual inspections began within ROWs. Inspection locations were spaced at 50-foot intervals, and at each inspection location, a 6-inch core was collected using a slotted soil recovery probe. The visual inspection was performed on this core that extended six inches into the subsurface (0 – 6 inches below ground surface (bgs)). Where the extent of suspected CCBs extended beyond ROWs and onto private property, property owners were identified and contacted with requests for access to continue the visual inspections on private property.

The CCB visual inspections were conducted along every road within the Area of Investigation, and extended out into private properties where warranted (and where access was granted). It is clear, based on historical evidence and visual inspection, that CCBs were used as fill only in a subset of the Area of Investigation.

Figure 4 depicts the information compiled about the potential locations of suspected CCBs at the ground surface within the Area of Investigation based on the visual inspections and the information presented in the RI Report (AECOM, 2010). As the figure shows, suspected CCBs are located in discrete areas in the Town of Pines predominantly associated with roadways, and are not distributed throughout all areas. However, the presence or absence of CCBs within the Area of Investigation at locations not otherwise identified as "field verified suspected" or "inferred suspected" CCB locations is not known at this time.

The visual inspection results for private properties where suspected CCBs were located at the surface indicated that the majority of the inspection locations had a suspected CCB content in the 1-25% range, some in the 25-50% range, and only a very few in the 50-75% range. None of the inspection locations were in the 75-100% CCB range.

For the purposes of the HHRA, the results of the CCB visual inspection program were tallied for 43 properties where suspected CCBs were identified at the ground surface. This was done by estimating the percent suspected CCBs present in each "exposure area," where an exposure area is defined as a residential lot or a subset of a residential lot if the lot size was large. In estimating the percent of suspected CCBs present across each exposure area, a conservative approach was taken by using methods that would result in the highest possible estimate of percent suspected CCBs present, as described below. The exposure area was defined for each property as essentially the size of the residential lot, but included the contiguous ROWs because most suspected CCBs within the Area of Investigation are located within the ROWs. In the few instances of a large property where suspected CCBs were located only within a smaller portion of that larger property, the exposure area was identified as approximately the size of a standard residential lot taking care to include the locations where suspected CCBs were identified. This refinement ensured that the large areas of these properties that did not have suspected CCBs at the surface did not "dilute out" the results for the areas where suspected CCBs were present. For each property:

- Each inspection location was plotted and the inspection result (no suspected CCBs, or suspected CCBs present within what classification range) was identified.
- The area where suspected CCBs were identified and the total exposure area were measured.
- For the area on each property where suspected CCBs were identified, the average percent of suspected CCBs present within that area was calculated (using the assumption that at each inspection location, the CCB amount was the maximum within the classification range).
- Then taking into account the size of the total exposure area, the size of the area with suspected CCBs present, and the average percent of suspected CCBs present within that area, the average percent suspected CCBs across the entire exposure area was calculated for each of the 43 properties.

This evaluation is presented in detail in Appendix I of the HHRA Report (AECOM, 2011a), and the results are presented here in Figure 7. This analysis demonstrated that 27% CCBs at the ground surface is the maximum average percent for any of the 43 properties (or exposure areas), and that the majority of the properties are below 15% suspected CCBs with an average of 6% suspected CCBs across all the properties where CCBs were located.

There is some uncertainty associated with the 27% CCB value derived from the visual inspections. However, the samples were classified by trained staff and the classifications were conducted to over-estimate rather than under-estimate the CCB content. The visual inspections identified many properties where CCBs were not present. Only properties where CCBs were present were included in the calculation of the maximum average percent CCBs. Also, for the exposure calculations, each inspection location was assumed to contain the maximum percent in the range of suspected CCBs in which it was classified, that is:

- all inspection locations in the 0-25% range were assumed to consist of 25% CCBs,

- all inspection locations in the 26-50% range were assumed to consist of 50% CCBs,

- all inspection locations in the 51-75% range were assumed to consist of 75% CCBs,

- all surface inspection locations that did not have a percent of suspected CCBs assigned were assumed to consist of 25% CCBs.

Note that there were no inspection locations identified in the 75-100% CCB range.

By including only those properties where the presence of suspected CCBs was identified, and by assuming each inspection location contained the maximum percent of CCBs within the classification range, uncertainty was highly biased toward estimating a high average percent of CCBs. Therefore, the method used to calculate the percent of CCBs present on each property was very conservative. In addition, the maximum calculated value (27%), was then used in evaluating potential risk.

As noted previously, the maximum percent CCBs at any property was calculated as 27%. The 27% value was used in the HHRA under the site-specific scenario for the residential and outdoor worker CCB exposure scenarios. The percent CCBs at the 43 properties surveyed ranged from a low of less than 1% to the maximum 27%. The following summary statistics and median and percentile values were calculated, as well as the 95% upper confidence limit (UCL). The UCL was calculated using ProUCL Version 4.1.01 (Attachment 1 of Attachment A in Appendix B provides the ProUCL output):

Summary statistics	
Minimum average percent CCBs	0.18%
Maximum average percent CCBs	27.38%
Mean average percent CCBs	6.77%
Percentiles of the average percent CCBs	
10^{th}	1.16%
50th (median)	5.19%
90^{th}	14.45%
UCL of average percent CCBs	
95% Approximate Gamma UCL	8.61%

As shown above, the estimates of the upper bound of the percent suspected CCBs are much lower than the maximum average percent used in the HHRA. The 95% UCL calculated by ProUCL is 8.6%, almost one quarter the value used in the HHRA. The 90^{th} percentile of 14.5% is almost half of the value used in the HHRA. The use of the maximum average percent CCBs to represent all the properties reduces the uncertainty, because the majority of properties contain a much lower percent CCBs.

To further demonstrate the conservative nature of the approach, an alternative estimate of the percent of CCBs present in each exposure area was derived, in which the midpoint of the percent within each classification range, instead of the maximum was used, that is:

- All inspection locations in the 0-25% range were assumed to consist of 12.5% CCBs,
- All inspection locations in the 26-50% range were assumed to consist of 37.5% CCBs,
- All inspection locations in the 51-75% range were assumed to consist of 62.5% CCBs,
- All inspection surface locations that did not have a percent of suspected CCBs assigned were assumed to consist of 25% CCBs.

Attachment 2 of Attachment A in Appendix B presents the calculations, which result in a maximum average percent of CCBs across each exposure area of 18%. Therefore, use of the midpoint would have been a reasonable choice in calculating the percent of CCBs present at each location. To reduce uncertainty and provide for a conservative estimation, the maximum was employed.

Summary

In estimating the percent of CCBs present across each exposure area in surficial soils (0 to 6 inches bgs), a conservative approach was taken by using methods that would result in the highest possible estimate, including the following:

- Including in the calculations only those properties on which suspected CCBs were identified;
- Inspecting many locations on each property to identify where suspected CCBs were located;
- Assuming the maximum percent of CCBs in each classification range;
- Using the highest percent CCBs on any property (27%) to represent the percent of CCBs present at all properties in surficial soils, rather than the 95% UCL (8%) or the 90^{th} percentile (15%).

This approach biases all of the calculations toward a higher than actual measure of the percent of CCBs present in surficial soils on residential properties in the Area of Investigation. Using the maximum 27% CCBs in the HHRA for the residential and outdoor worker CCB scenarios provides a conservative estimate of potential exposure and risk in the Area of Investigation. Developing remedial decisions without the use of this critical site-specific information may misguide those decisions. While there is no information as to the percent CCBs in subsurface soils, the majority of potential residential exposure is to surface soils.

The exposure point concentrations (EPCs) used in the HHRA were also developed to provide an upper-bound estimate of risk. The EPCs were based on the 95% UCL on the arithmetic mean of the data from the MWSE sampling. This statistical treatment accounts for a 5% chance that specific sample locations may have a concentration greater than the EPC. The calculation of the 95% UCL, using USEPA's ProUCL software, takes into account the variability in the data, for example, where the data are more variable, the 95% UCL will be higher. Therefore, although there may be some locations where an analytical result may be higher than the 95% UCL, that result is unlikely to represent the average concentration across a given property. As described in USEPA guidance, the reasonable maximum exposure (RME) scenario is not meant to define the absolute maximum of all exposure inputs, but rather reasonable upper bounds. However, it is possible that at a given property there could be higher concentrations and/or higher variability than found in the MWSE data set.

2.2.2 Chemistry of Background Soil

The natural soils in the Area of Investigation include both granular soils (primarily dune sands, but also silts and clays) and organic soils, which may be mixed with granular materials. All of the natural geologic materials contain a wide variety of metals at different concentrations, such as aluminum (Al), arsenic (As), B, barium (Ba), cadmium (Cd), calcium (Ca), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), magnesium (Mg), manganese (Mn), mercury (Hg), nickel (Ni), potassium (K), sodium (Na), selenium (Se), strontium (Sr), sulfur (S), (uranium) U, vanadium (V), and zinc (Zn). Notably, As was present in all the background soil samples at concentrations above the risk-based comparison level for human health. This is not unexpected, as As is present at concentrations above risk-based comparison levels in most natural soils in the United States. Mn and thallium (Tl) were detected in one background soil sample at concentrations above the human health risk-based comparison level. Levels of the radionuclides Pb-210, radium (Ra)-226, and Ra-228 were also greater than human health comparison levels in most samples. None of these soil samples is significantly affected by CCB-derived constituents; instead, the results reflect the natural and anthropogenic levels of metals and radionuclides in soils in the area. Potential risks associated with background soils were evaluated quantitatively in the risk assessments.

Five of the background samples were analyzed for particulate matter to determine if CCBs are present in the samples. Three (3) of them were reported to contain trace levels of CCBs. One sample was reported to contain 1% bottom ash and a trace amount (<0.25%) fly ash, one sample was reported to contain 0.75% bottom ash and a trace amount (<0.25%) fly ash, and one sample was reported to contain <0.25% fly ash. Figure 11 shows the locations of the background samples and the results for the particulate matter analysis. To evaluate the potential impact of using background samples which may contain up to 1% CCBs, the background EPCs were adjusted downwards in a sensitivity analysis to subtract out the concentration potentially associated with 1% CCBs. The background EPCs with the 1% CCBs subtracted were then used to re-calculate the potential background risks and hazards using the same methods as used in the HHRA. The potential risk and hazard estimates are only very slightly lower than those estimated in the HHRA. Therefore, the inclusion of background samples that may contain up to 1% CCBs has virtually no influence on the comparison between potential risks associated with suspected CCBs and background soils. The details of this evaluation are presented in Attachment B of Appendix B.

2.2.3 Chemistry of Suspected CCBs

A total of 34 suspected CCB samples were collected from 34 utility trench locations during the MWSE installation, and analyzed for metals and inorganics. Most of the metals present in suspected CCBs are also present in background soils, although concentrations for some are higher in suspected CCBs. The As concentrations in all the suspected CCB samples were above the risk-based comparison level as were all of the As concentrations in all the background soils. Iron was also present in many suspected CCB samples at concentrations above the risk-based comparison level for human health. Hexavalent Cr was detected and above the human health risk-based comparison level in all of the suspected CCB samples in which it was analyzed. However, it should be noted that the validity of the draft toxicity value upon which the comparison level is based has been questioned by USEPA's Science Advisory Board (SAB). The SAB review can be accessed at http://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=221433. A finalized value is not yet available.

To evaluate radionuclides in suspected CCBs, a subset of 10 of the samples collected during the MWSE installation were analyzed using approved analytical methods. Data collection for the purposes of the human health risk assessment focused on radiological analysis of discrete CCB samples. In addition, 10 samples collected from the Type III (South) Area of Yard 520 were also analyzed for radionuclides.

Potential risks associated with suspected CCBs were evaluated quantitatively in the risk assessments.

2.2.4 Chemistry of Groundwater

The natural background groundwater in the Area of Investigation includes many minerals, typical of most natural fresh waters in the world. These include major ions such as Ca, Mg, Na, silicon (Si), bicarbonate (HCO_3), sulfate (SO_4), and chlorine (Cl), and minor and trace elements such as Al, Ba, B, Mn, Sr, and nitrate (NO_3). Based on RI sampling, background concentrations of B in the surficial aquifer in the Area of Investigation range up to 0.119 milligrams per liter (mg/L); Mo up to 0.012 mg/L. The USGS has documented that natural levels of B in the deeper confined aquifers can be expected to be above both the USEPA's RAL of 0.900 mg/L and the human health risk-based comparison level of 0.730 mg/L.

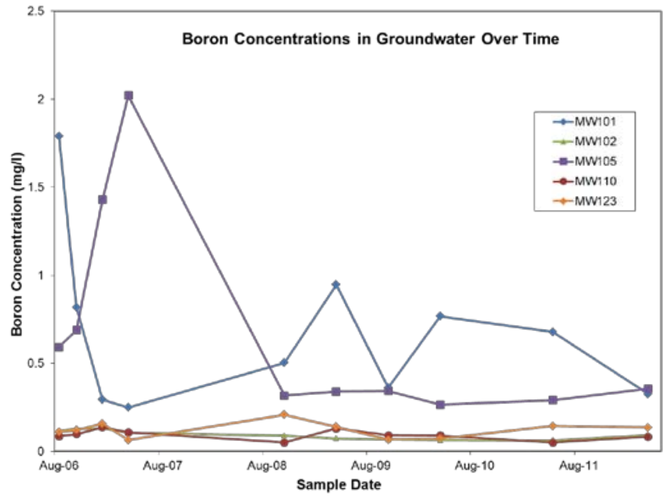
Based on the RI data, CCB-derived constituents in groundwater include B, SO_4, Ca, Mg, Sr, and Mo. As also appears to migrate from CCBs to groundwater, at least at Yard 520, but it is not transported any significant distance with the groundwater. Fe and Mn may also have the potential to migrate from CCBs to groundwater, but their mobility in groundwater is controlled by redox conditions. Of these, the RI Report indicated that B, Mo, SO_4, As, Fe, and Mn were present in at least one groundwater sample at concentrations above human health risk-based comparison levels. Other constituents detected at least once at concentrations above comparison levels included Se, Cl, and NO_3, but these are not likely to be CCB-derived.

Migration from CCBs to groundwater appears to occur where large volumes of CCBs are present, such as at Yard 520 and areas where suspected CCBs extend significantly beyond roadways. The relationship between the presence of suspected CCBs and boron in groundwater is shown on Figure 8. It is uncertain whether migration from CCBs to groundwater occurs where CCBs are used only as road sub-base, as constituent concentrations are generally low in these areas (see below). In at least one monitoring well location (MW111), elevated CCBs occur in an area of known road sub-base and underlying road fill combined (five feet of thickness as documented in the boring log for MW111). Possible larger accumulations of CCBs nearby (i.e., to the east of Illinois Avenue) may also contribute to concentrations in groundwater, as well as areas located around test pit TP026 (greater than four and a half feet of CCB fill) and TP027 (greater than seven feet of CCB fill), which are located upgradient of MW111. Several wells are located in or downgradient from areas where suspected CCBs are present only as road sub-base, including MW107, MW108, MW114, and PW005, as shown on Figure 9. These wells do not show the presence of elevated levels of boron. In addition to the smaller amounts of suspected CCBs present, the paving of roadways may reduce groundwater recharge and migration of CCB-related constituents to groundwater.

The RI has documented the extent of CCB-derived constituents in groundwater. Concentrations of B, SO_4, Ca, Mg, Sr, and Mo are elevated at and downgradient from Yard 520. To the east, elevated concentrations of these constituents are present in the vicinity of areas where suspected CCBs may have been used as fill (that is, they are present beyond the roadways), and downgradient to the south as far as the East Branch of Brown Ditch. Hydraulic gradients indicate that all groundwater containing CCB-derived constituents flows towards and into the Brown Ditch system, including its related tributaries and wetlands. The interpreted extent of elevated boron in groundwater is shown on Figure 9.

In addition, groundwater from Yard 520 flows into Brown Ditch and its related tributaries and wetlands in the immediate vicinity of Yard 520, and the hydrogeologic studies performed as part of the RI have demonstrated that groundwater does not flow from Yard 520 to the south beneath Brown Ditch. Also, based on the available information, CCB-derived constituents in groundwater do not extend northward into IDNL at levels of significance. CCB-derived constituents in groundwater do not currently appear to extend to areas where private water wells are located outside the area currently supplied by municipal drinking water.

In addition to CCB-derived constituents in groundwater, the groundwater in the surficial aquifer beneath the Area of Investigation shows evidence of other sources of impact, including septic system discharges, road salt, and the Pines Landfill (owned by Waste Management). Elevated concentrations of a number of non-CCB-derived constituents, such as Na, Cl, NO_3, ammonia (NH_4), and bacteriological parameters, were detected in many samples. Groundwater directly south of Yard 520 and Brown Ditch appears to be impacted by a landfill to the south (Pines Landfill, owned by Waste Management). Concentrations of B in monitoring wells in this area are most likely a result of landfill contaminants. Fe and Mn are elevated in a number of wells, including from one background well (MW113), un-related to CCBs. Natural levels of Fe and Mn are common in groundwater in many areas of the country, including in northern Indiana, and are commonly the cause of unpleasant taste and appearance of well water.



Since completion of the RI sampling, the Respondents have continued to sample a subset of monitoring wells. The purpose of this sampling is to identify whether CCB-derived constituents in groundwater are migrating farther northward. The additional monitoring conducted during the four years after the RI was completed has shown that the extent of CCB-derived constituents in groundwater has not expanded northward. Furthermore, concentrations have decreased in some of the wells, as shown on the graph to the right, indicating that the extent of the CCB-derived constituents has decreased. Concentrations at MW101 and MW105 have decreased significantly since their maximum concentrations measured during the RI. MW110 and MW123 are the northernmost wells, located north of West Dunes Highway and upgradient from IDNL. The concentration of B in these wells has consistently remained low, indicating that CCB-related constituents do not extend to IDNL, nor is there any indication they are currently migrating towards INDL. The post-RI groundwater data are included in Attachment C of Appendix B. All results from these wells are below the tap water Regional Screening Level (RSL) for B.

In addition to sampling selected wells, the Respondents continue to measure water levels at all wells and surface water monitoring locations. Groundwater levels fluctuate slightly on a seasonal basis, generally being higher in the winter and spring and lower in the summer and fall (growing season). Overall, there has been no significant change in groundwater levels or hydraulic gradients since the completion of the RI field work. Because gradients have not changed, it is unlikely that constituents in groundwater would migrate in different directions, that is, it is unlikely that CCB-derived constituents would migrate to areas where they were not present during the RI.

2.2.5 Chemistry of Surface Water

The upgradient (background) surface water contained measurable levels of metals and other constituents. The presence of these naturally occurring constituents in the surface water samples is not unexpected and, in many cases, can be attributed to weathering and erosion of local soils, sediments, and geologic formations as well as anthropogenic influences such as agricultural practices and run-off from roadways and railroads. The dissolved oxygen (DO) concentrations in upgradient locations were relatively low, especially in the summer and early fall, such that Brown Ditch would not support a coldwater fishery, and even warmwater fish may be seasonally stressed in some locations.

The RI Report indicated that, in upgradient surface water, concentrations of Al, Fe, Mn, and V were above the associated ecological comparison level in one or more samples. The concentration of Mn was above the human health comparison level in one sample, and this was the only surface water sample with a constituent present at a level above a human health comparison level. The presence of Al in surface water is associated with suspended solids in the water, as measured by Total Suspended Solids (TSS). Total Fe and Mn concentrations also are likely to be a function of the amount of particulate matter in the samples. Dissolved Fe and Mn can be associated with low DO and associated redox conditions.

The Brown Ditch surface waters (that is, within the Area of Investigation, downgradient of the upgradient locations) also contained measurable levels of metals and other constituents. As with the upgradient locations, the presence of these naturally occurring constituents in the surface water samples is not unexpected and, in many cases, can be attributed to weathering and erosion of local soils, sediments, and geologic formations. However, concentrations of several metals were higher than in upgradient samples.

The RI Report indicated that concentrations of B in surface water were above the human health and ecological comparison levels in certain samples in the West, East, and Main Branches of Brown Ditch. Typically, higher concentrations were measured in the summer (dry period). In the West Branch, some of these samples also have Mo concentrations above the human health risk-based comparison level but not the ecological comparison level. These elevated concentrations of B and Mo are most likely due to the contribution of groundwater containing CCB-derived constituents to the ditches.

Concentrations of Al were above its ecological comparison level in many surface water samples, both at upgradient and Brown Ditch locations. The Al appears to be associated with sediment and suspended particles in the samples as measured by the TSS. Al concentrations are generally higher in upgradient samples.

Concentrations of Fe and Mn were above the associated ecological comparison levels in many upgradient and Brown Ditch sample locations but only one Brown Ditch sample of Fe was above the human health comparison level. The total fraction of these constituents may also be associated with suspended sediment in the samples; the dissolved fraction may be associated with locally low levels of DO in some segments of the ditches.

2.2.6 Chemistry of Sediments

In upgradient (background) locations, sediment samples are typically sandy with low levels of organic material. Boron was not detected in any upgradient sediment samples; however, the detection limit for B in sediments was elevated for all samples analyzed. Pb, Se, and Ba were above the ecological comparison levels in upgradient sediment samples, and As concentrations were above the human health comparison level. The presence of these metals in background sediments shows that sediments outside of areas that could be affected by CCB-derived constituents contain concentrations of some metals that are above risk-based comparison levels.

The sediments in Brown Ditch (that is, at locations within the Area of Investigation, downgradient of the upgradient locations) included both sandy and highly organic sediments. In contrast with the upgradient samples, the majority of the Brown Ditch samples contained greater than 1% total organic carbon (TOC). The percentage of fine-grained material (silts and clays) was also generally higher in downgradient samples. These differences reflect differences in the depositional environments between upgradient and Brown Ditch locations.

The Brown Ditch sediments contained metals and other constituents. The presence of these naturally occurring constituents in the sediment samples is not unexpected and, in some cases, can be attributed to weathering and erosion of local soils, sediments, and geologic formations. Boron was detected in two sediment samples from Brown Ditch, SW022 and SW026; however, as noted above, the detection limit for B in sediments was elevated for all samples analyzed. Based on their locations and B concentrations, B in these sediments is likely associated with groundwater containing CCB-derived constituents. There are no ecological risk-based comparison levels for B in sediment. The concentrations are below the human health risk-based comparison level.

In general, concentrations of many metals in the Brown Ditch sediments were greater than concentrations at upgradient locations, consistent with the finer-grained and more organic nature of many of the Brown Ditch system sediment samples. Concentrations of As, Ba, Cu, Fe, Pb, Mn, Ni, Se, V, and Zn in the Brown Ditch sediments for some locations were above associated ecological risk-based comparison levels. Results for Al, Cd, or Cr in Brown Ditch sediments were below associated ecological risk-based comparison levels. All detected concentrations of As in the Brown Ditch sediments, some detected concentrations of Fe, and one detected Tl concentration are above human health risk-based comparison levels.

The interpretation of some metals in Brown Ditch sediments may be confounded by the higher percentage of fines, higher TOC concentrations, lower percent solids, and presence of other potential sources in Brown Ditch sediments compared to upgradient sediments, but the concentrations of some metals are clearly elevated in samples located in proximity to significant CCB sources. When the percentage of fines is taken into account, concentrations of most metals (except for soluble CCB-related constituents such as B and Mo) are similar to upgradient concentrations and there is no consistent spatial pattern that can be attributed to CCB-derived constituents. A formal statistical comparison to upgradient concentrations was conducted as part of the Risk Assessments.

2.2.7 Fate and Transport

Constituents present in environmental media will be affected by various attenuation processes as they migrate that will tend to reduce their concentrations. In groundwater, B, SO_4, Ca, Mg, and Sr are highly soluble and not very chemically reactive. Therefore, they are less likely to participate in chemical reactions that remove them from groundwater. They will typically be transported downgradient with the groundwater flow, with concentrations reduced primarily through dispersion. These constituents will then enter surface water in the Brown Ditch system with the groundwater. The fate and transport of Mo is similar, except that it appears to be subject to some additional attenuation processes, at least locally.

The fate and transport of Fe, Mn, and As in groundwater are controlled by redox conditions. Where groundwater is oxidized, these constituents will form insoluble molecules and will be removed from the groundwater system. Where groundwater is reduced, these molecules will dissociate and release the constituents into the groundwater. This process occurs with naturally-occurring Fe, Mn, and As in the native soils in the Area of Investigation as well as any Fe, Mn or As that might migrate from CCBs. Reducing conditions in groundwater are present locally throughout the Area of Investigation, most likely caused by organic inputs to the groundwater, such as septic system discharges, wetlands and highly organic soils, former gasoline stations, and the Pines Landfill (owned by Waste Management). Where such reducing conditions are present near the Brown Ditch system, including its associated wetlands, these constituents could be mobile and enter the ditch with the groundwater. Where groundwater near the ditches is oxidized, Fe, Mn and As will not be mobile and, therefore, will not migrate into surface water.

In surface water, constituent concentrations tend to decrease with distance downstream from sources due to mixing and dilution. When constituents partition from the pore water into the sediments, they are less available to interact with ecological receptors. Uptake of nutrients by plant life can reduce concentrations in sediment and surface water. Biological processes in general can transform constituents and affect their fate and mobility (e.g., denitrification). In addition, the potential ecological effects of some constituents in surface water can be hardness dependent. CCB-derived constituents are not considered bioaccumulative.

2.3 HHRA

The HHRA was conducted as part of the RI/FS process in order to evaluate the potential risks to human receptors posed by CCB-derived constituents in environmental media within the Area of Investigation. A baseline HHRA was conducted for the Area of Investigation in accordance with the four-step paradigm for human health risk assessments developed by USEPA (USEPA, 1989a): 1) Hazard Identification, 2) Dose-Response Assessment, 3) Exposure Assessment, and 4) Risk Characterization. A summary of each step is presented below, followed by results and conclusions.

2.3.1 Hazard Identification

The purpose of the hazard identification process is two-fold: 1) to evaluate the nature and the extent of release of CCB-derived constituents present within the Area of Investigation; and 2) to identify a subset of these constituents as constituents of potential concern (COPCs) for quantitative evaluation in the risk assessment.

COPCs were identified using a series of screening steps, including frequency of detection, comparison of maximum detected concentration to screening levels, comparison to background, and essential nutrient status.

The following COPCs were designated for quantitative evaluation in the HHRA[1]:

> Chemical Constituents: Al, As, B, Cr (VI) (hexavalent chromium), cobalt (Co), Fe, Mn, Mo, Se, Sr, Tl, and V.
>
> Radionuclides: Detected radionuclides were grouped according to their decay series and selected as COPCs using the "+D" or "+daughters" designation and slope factors as appropriate. Polonium (Po)-210 was detected but is included as a COPC as part of the Pb-210 decay chain and was not included as a separate radionuclide in the calculations. Radionuclides selected as COPCs include: U-238+D, U-234, Thorium (Th)-230, Ra-226+D, Pb-210+D, U-235+D, Th-232, Ra-228+D, and Th-228.

2.3.2 Dose-Response Assessment

The purpose of the dose-response assessment is to identify the types of adverse health effects a constituent may potentially cause, and to define the relationship between the dose of a constituent and the likelihood or magnitude of an adverse effect (response) (USEPA, 1989a). Adverse effects are classified by USEPA as potentially carcinogenic or noncarcinogenic (i.e., potential effects other than cancer). Dose-response relationships are defined by USEPA for oral and inhalation exposures. Oral toxicity values are also used to assess dermal exposures, with appropriate adjustments, because USEPA has not yet developed values for this route of exposure (USEPA, 1989a). The USEPA's guidance regarding the hierarchy of sources of human health dose-response values in risk assessment was followed (USEPA, 2003) for chemical constituents; sources of the published dose-response values used in the HHRA are further detailed in that report.

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[1] Note that not all constituents are COPCs in all media.

2.3.3 Exposure Assessment

The purpose of the exposure assessment is to predict the magnitude and frequency of potential human exposure to each of the COPCs retained for quantitative evaluation in the HHRA. First, potential exposure pathways are identified, then EPCs for each COPC are determined.

Exposure pathways and receptors were evaluated and selected in the HHRA based on the location of source areas, potential migration pathways of constituents from source areas to environmental media where exposure can occur, and current and future site uses. Ultimately, three general groups of receptors were evaluated in the HHRA:

- Residential receptors: Residential receptors were assumed to be potentially exposed to COPCs in suspected CCBs via incidental ingestion, dermal contact, inhalation of dusts, and via external exposure to gamma radiation. The residential child was also assumed to wade or swim in a local water body, was assumed to be potentially exposed to surface water via dermal contact (and via incidental ingestion for the swimming scenario) and sediment via incidental ingestion and dermal contact, and ingest fish. The residential child was also assumed to be potentially exposed to radionuclides in Brown Ditch sediment via incidental ingestion and external exposure. In a hypothetical screening level scenario, it was conservatively assumed that the receptor's entire residential exposure area is comprised of CCBs and that all contact that would normally be assumed to occur with soils would occur with CCBs – this is a hypothetical scenario that has been shown to not be representative or even exist within the Area of Investigation by the extensive CCB visual inspection program conducted as part of the RI (refer to previous discussion). As presented in the HHRA (and discussed above), the percent of suspected CCBs at the ground surface at each residential property was calculated, with values ranging from a low of less than 1% CCBs to a maximum estimated 27%. Therefore, a second site-specific scenario (i.e., using a site-specific maximum 27% CCB scenario) was evaluated in the HHRA. Assuming gardens are present within areas containing suspected CCBs, residential adults and children may potentially be exposed to COPCs in produce. Where groundwater is used as a source of drinking water (i.e., outside the area that has been supplied municipal water), residents may be exposed to CCB-derived constituents that may have migrated into groundwater. The drinking water pathway is only potentially complete for those residents who use groundwater from the surficial aquifer as a drinking water source.

- Recreational receptors were assumed to be potentially exposed to COPCs in suspected CCBs in dust via inhalation, and to COPCs via dermal contact with surface water while wading or swimming in a local water body, via incidental ingestion and dermal contact with sediment while wading or swimming, and via ingestion of fish caught in a local water body. Both the recreational fisher and the recreational child were assumed to ingest fish. The recreational receptors were also assumed to be potentially exposed radionuclides in Brown Ditch sediment via incidental ingestion and external exposure.

- Industrial receptors (construction workers and outdoor workers) were assumed to be exposed to suspected CCBs via incidental ingestion, dermal contact, inhalation of dusts, and external exposure to gamma radiation. The construction worker was also assumed to be potentially exposed to COPCs in groundwater during excavation. The outdoor worker is assumed to be exposed to materials at the ground surface and, therefore, both the hypothetical screening level 100% CCB and the site-specific 27% CCB scenarios are evaluated for this receptor.

The construction worker scenario conservatively assumes that all excavations occur through suspected CCBs, thus only the 100% CCB scenario was evaluated for this receptor.

RME scenarios and central tendency exposure (CTE) scenarios based on appropriate USEPA guidance were both evaluated in the quantitative risk assessment. Each of the scenarios evaluated represent conservative exposure assumptions that are more likely to over-estimate than under-estimate risk. For example, a residential child of 0-6 years of age is assumed to wade in Brown Ditch 26 days per year for 2 hours each day for a total of 52 hours each year, to consume 13 meals of fish caught from Brown Ditch each year, and to contact and ingest CCBs and inhale CCB-derive dusts from a residential yard 250 days per year, among other assumed exposures.

EPCs for media being evaluated in the HHRA were derived from measured data. Where possible, EPCs were the lower of the maximum detected concentration and the 95% UCL, per USEPA guidance. Where too few data points were available to calculate the 95% UCL, the maximum detected concentration was selected as the EPC. EPCs for fugitive and excavation dusts were calculated from suspected CCB or soil concentrations based on USEPA models. Fish tissue concentrations were derived from surface water concentrations using water-to-fish uptake factors.

The data used in the HHRA were from the MWSE sample locations along roadways that are adjacent to residential properties. Where the road sub-base extends onto yards and properties, the MWSE data can be assumed to be representative of the suspected CCBs identified on those properties. Where larger areas were filled beyond the road sub-base, available information (such as aerial photograph, town records, NIPSCO records) indicates this material is expected to have the same chemical composition as the material used in the roads. This is discussed in more detail in the HHRA. The EPCs were based on the 95% UCL on the arithmetic mean of the 34-point dataset from the MWSE sampling. This statistical treatment accounts for a 5% chance that specific sample locations may have a concentration greater than the EPC. The calculation of the 95% UCL, using USEPA's ProUCL software, takes into account the variability in the data. In instances where data are more variable, the 95% UCL will be higher. Therefore, although there may be some location where an analytical result may be higher than the 95% UCL, that result is unlikely to represent the average concentration across a given property. As described in USEPA guidance, the RME scenario is not meant to define the absolute maximum of all exposure inputs, but rather reasonable upper bounds. However, it is possible that at a given property there could be higher concentrations and/or higher variability than found in the MWSE data set.

2.3.4 Risk Characterization

The potential risk to human health associated with potential exposure to COPCs in environmental media in the Area of Investigation was evaluated in this step of the risk assessment process. Risk characterization is the process in which the dose-response information is integrated with quantitative estimates of human exposure derived in the Exposure Assessment. The result is a quantitative estimate of the likelihood that humans will experience any adverse health effects given the exposure assumptions made.

The potential carcinogenic risk for each exposure pathway was calculated for each receptor. In current regulatory risk assessment, it is assumed that carcinogenic risks are cumulative. Pathway and area-specific risks are summed to estimate the total potential carcinogenic risk for each receptor. The total potential carcinogenic risks for each receptor group are compared to the USEPA's target risk range of 10^{-4} to 10^{-6}. A COPC that poses a risk within or above the USEPA target risk range of 10^{-4} to 10^{-6} for a particular receptor is designated a constituent of concern (COC). The target risk levels used for the identification of COCs are based on USEPA guidance and were identified in the approved HHRA Work Plan (ENSR, 2005b). Specifically, USEPA provides the following guidance (USEPA, 1991b):

> "EPA uses the general 10(-4) to 10(-6) risk range as a "target range" within which the Agency strives to manage risks as part of a Superfund cleanup. Once a decision has been made to make an action, the Agency has expressed a preference for cleanups achieving the more protective end of the range (i.e., 10(-6)), although waste management strategies achieving reductions in site risks anywhere within the risk range may be deemed acceptable by the EPA risk manager. Furthermore, the upper boundary of the risk range is not a discrete line at 1 x 10(-4), although EPA generally uses 1 x 10(-4) in making risk management decisions. A specific risk estimate around 10(-4) may be considered acceptable if justified based on site-specific conditions, including any remaining uncertainties on the nature and extent of contamination and associated risks. Therefore, in certain cases EPA may consider risk estimates slightly greater than 1 x 10(-4) to be protective."

And

> "Where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4}, and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts."

In addition, IDEM offers the following guidance regarding target risk level:

> "The Indiana Risk Integrated System of Closure (RISC) [IDEM. 2001. Risk Integrated System of Closure Technical Guide. February 15, 2001.], and the latest IDEM guidance [IDEM. 2012. Remediation Closure Guide. March 22, 2012. http://www.in.gov/idem/6683.htm] uses the target risk range of 1E-06 to 1E-04. The IDEM residential soil screening levels are set at a 1E-05 target risk level [see Appendix A of IDEM, 2012]. Section 7.6 of the IDEM guidance document states: "The cumulative hazard index of chemicals that affect the same target organ should not exceed 1, and the cumulative target risk of chemicals that exhibit the same mode of action should not exceed 10^{-4}. U.S. EPA risk assessment guidance views these criteria as "points of departure", and IDEM will generally require some further action at sites where these risks are exceeded. Further action may include remediation, risk management, or a demonstration utilizing appropriate lines of evidence that the risk characterization overstates the actual risk."

The potential for exposure to a constituent to result in adverse noncarcinogenic health effects is estimated for each receptor by comparing the dose for each COPC with the reference dose (RfD) for that COPC. The resulting ratio, which is unitless, is known as the hazard quotient (HQ) for that constituent. The target HQ is defined as an HQ of less than or equal to one (USEPA, 1989a). When the HQ is less than or equal to 1, the RfD has not been exceeded, and no adverse noncarcinogenic effects are expected. If the HQ is greater than 1, there may be a potential for adverse noncarcinogenic health effects to occur; however, the magnitude of the HQ cannot be directly equated to a probability or effect level. HQs for a given pathway are summed to provide a hazard index (HI). Pathway HIs are summed to provide a total receptor HI. When the HI is less than 1, the target has not been exceeded, and no adverse noncarcinogenic effects are expected. This initial HI summation assumes that all the COPCs are additive in their toxicity, and is considered only a screening step because additive toxicity may not occur. If the HI is greater than 1, further evaluation is necessary to determine if the COPCs are additive in toxicity. This evaluation is termed a target endpoint analysis. COPCs that cause an exceedance of a target-endpoint specific HI of 1 are designated COCs.

The HHRA results are discussed below and summarized in Table 1 for the non-drinking water exposure scenarios, and in Table 2 for the drinking water scenario evaluation. For the purposes of this memorandum, the discussion and the results in the tables focus on the RME scenario.

2.3.4.1 Results of Chemical and Radiological Risk Assessment – Non-Drinking Water Pathways

The results of the chemical and radiological risk assessment are presented in Table 1 for the non-drinking water pathways. Based on the discussion in Section 2.2.1 above, results shown in Figure 7, and based on the detailed discussion in the HHRA Report, the 27% CCB exposure scenario for the residential receptor and the outdoor worker is site-specific and it represents an RME scenario. Therefore, the hypothetical screening-level 100% CCB scenario results are presented in Table 1 for context, but the discussion below focuses on the results of the 27% CCB scenario evaluation for the residential receptor and the outdoor worker. The 27% CCB scenario is applicable only to residential and outdoor worker potential exposures to CCBs. Construction workers were assumed to contact 100% CCBs, and recreational receptors were assumed to breathe dusts derived from 100% CCBs. Surface water, sediment, and fish tissue exposures for both recreational and residential receptors are unrelated to the %CCB exposure scenario. Therefore, construction worker and recreational receptor potential risks and hazards are presented under the 100% CCB scenario. Potential risks and hazards for residential and outdoor worker receptors are presented under both scenarios. However, it should be noted that since potential risks and hazards for the residential receptor for surface water, sediment, and fish tissue are unrelated to the %CCB exposure scenario, they are the same under both the 27% and the 100% scenarios.

<u>Summary of Potential Background Risks</u>

Background data were evaluated in the HHRA for the residential scenario. Potential carcinogenic risks were within the 10^{-4} to 10^{-6} range.

Further, the HQ for Tl for the background dataset is greater than the noncarcinogenic target hazard index of one. As discussed in greater detail in the HHRA Report, the endpoint for Tl is hair follicle atrophy, and the provisional toxicity value provided by USEPA is not necessarily recommended for use. All other target endpoint HQs for background soil are below one.

<u>Summary of Constituent Specific Risk Results</u>

No potential risks greater than 10^{-4} were identified in the chemical HHRA for any of the receptor scenarios evaluated. Potential carcinogenic risks within the 10^{-4} to 10^{-6} target risk range (i.e., greater than 10^{-5} and/or greater than or equal to 10^{-6}) were identified for some, but not all, site-specific 27% CCB RME pathways and scenarios, while no constituents with potential risks greater than or equal to 10^{-5} were identified under the site-specific 27% CCB CTE scenario. Potential risks greater than 10^{-6} were not identified for the construction worker under RME or CTE scenarios. Potential risks greater than 10^{-6} but less than 10^{-5} were identified for the recreational child and the recreational fisher sediment scenarios (and these components of the residential scenario). Potential risks greater than 10^{-6} were not identified for surface water or fish ingestion. Based on USEPA's request, COCs have been identified as those constituents with risks greater than 10^{-6} and/or a target endpoint HI of one. These are shown on Tables 1 and 2.

A hazard index of one was not exceeded for any of the site-specific 27% CCB scenarios, sediment or surface water scenarios, or construction worker contact with groundwater scenarios. Therefore, no COCs have been identified for noncarcinogenic effects.

Potential exposures and risk via the homegrown produce consumption pathway are within the low end of the range of exposure and risk for the normal background dietary ingestion of arsenic, indicating that potential carcinogenic risk from ingesting homegrown produce containing arsenic is likely not a human health concern.

Comparison of Risks for Background and CCB Scenarios

Although As in suspected CCBs was not found consistent with background, the potential risk from As in background soils is of the same order of magnitude as the potential risk from As in suspected CCBs. Potential risks for the RME resident for As from suspected CCBs are $1x10^{-5}$ (site-specific 27% CCB scenario), and $2x10^{-5}$ from background soils.

In addition, the potential residential RME risk from radionuclides in background soils is of the same order of magnitude as the potential residential RME risk from radionuclides in suspected CCBs. Potential risks for the RME resident garden scenario are $4x10^{-5}$ (site-specific 27% CCB scenario), and $2x10^{-5}$ for background soils.

As discussed in the USEPA-approved HHRA Report (Section 6.5.3.2), historical information indicates that the suspected CCBs present in residential lots are expected to be the same as CCBs encountered in rights-of-way (and sampled under the MWSE SAP). Thus the MWSE sample results provide a robust data set that is a reasonably conservative representation of suspected CCBs within the Area of Investigation. As such, the MWSE sample data and related HHRA results provide a starting point for risk management decisions and provide a good overall representation of residential exposure conditions across the Area of Investigation.

Evaluation of Regulatory Standards for Radionuclides

In addition to the radionuclide risk assessment, the HHRA included an evaluation of data with respect to regulatory standards for radionuclides. USEPA guidance[2] identifies a standard of 5 picoCuries per gram (pCi/g) above background that is used to assess the combined levels of Ra-226 and Ra-228. The background soil data collected during the RI were used to statistically derive a background threshold value (BTV) for the sum of the Ra isotopes, which ranged from 1 to 2 pCi/g; therefore, the resulting 5 pCi/g plus background range is 6 to 7 pCi/g. As shown in HHRA, all of the results from the suspected CCB dataset, the Brown Ditch sediment dataset, and the upgradient sediment dataset are below this 5 pCi/g plus background range.

2.3.4.2 Results of Drinking Water Risk Assessment

The evaluation of the drinking water pathway was conducted in two parts. First, a cumulative screen was used to identify constituents above 10^{-6} or a hazard index of one in each well for which RI data were collected. Second, data for wells located outside of the municipal water service area was

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[2] 40 CFR 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings." at 40 CFR §192.12.

evaluated to determine if those wells were impacted by CCB-derived constituents. This analysis is summarized in Table 2.

Cumulative Risk Screen

The HHRA included a cumulative risk screen to evaluate the residential drinking water pathway. The screen used the RSLs for residential tap water (USEPA, 2011) and, therefore, is protective of other potential drinking water exposure scenarios (e.g., a visitor to the area). The RSLs incorporate agency default, conservative exposure assumptions as well as agency selected toxicity values. Thus, the potential risks and hazards estimated using the RSLs are conservative and are likely overestimates of potential risks and hazards. Analytical data for private wells and RI monitoring wells were compared to RSLs using this cumulative screening approach. A cumulative screen is in essence a risk assessment in which potential risks and hazards are calculated based on the default screening levels.

No constituents with risks greater than 10^{-6} or a total endpoint-specific HI greater than one were identified in any private well. No constituents with risks greater than 10^{-4} or a total endpoint-specific HI greater than one were identified in any background well, although arsenic was identified in background well MW120 with a potential risk greater than 10^{-5}.

Within the MWSE area, constituents with risks greater than 10^{-4} or a total endpoint specific HI greater than 1 were identified only in monitoring wells in the immediate vicinity of Yard 520 (MW-3, MW-6, MW-8, MW-10, TW-12, TW-15D, TW-16D, and TW-18D). Potential risks above 10^{-5} were identified for arsenic in MW104, within the MWSE area; however, the chemistry of this well indicates septic impacts.

Outside of the MWSE area, constituents with potential risks greater than 10^{-4} and a target endpoint specific HI greater than one were identified only for MW111 and MW122, which are in the wetland areas bordering Brown Ditch and downgradient of significant deposits of CCBs or suspected CCBs. Figure 10 presents these results.

Evaluation of CCB-Derived Constituents

The objective of the RI was to evaluate CCB-derived constituents. As such, the drinking water pathway would not be complete if wells are not likely impacted by CCBs, or for which COPCs are not identified. An analysis was conducted to determine whether wells outside the MWSE area are potentially impacted by CCBs. Based on that analysis, although the presence of CCB-derived constituents cannot be entirely ruled out for some wells outside of the MWSE area, the fact that the concentrations of constituents that may be CCB-derived are so low as to not be identified as COPCs suggests that if this pathway is complete, it is insignificant. Therefore, the drinking water pathway for exposure to CCB-derived constituents in the area outside the municipal water service area is likely incomplete, with the exception of MW111 and MW122, where total potential risks exceeded 10^{-4} and the total potential hazard index exceeded one. These two wells are located in wetland areas that are unlikely to be developed, though such development in the future cannot be precluded. However, MW111 and MW122 are in areas that could easily be provided municipal water if developed in the future to avoid the potentially unacceptable risks identified in the HHRA.

Similarly, the drinking water pathway within the area of the municipal water service would potentially be complete only where locations have not been connected to municipal water and where wells are screened in the shallow surficial aquifer, and only in those areas in the immediate vicinity of Yard 520 where COPCs have been identified. Thus, this evaluation of the drinking water pathway indicates that

CCB-derived constituents in groundwater used as drinking water outside of the immediate vicinity of Yard 520, whether within or outside of the municipal water service area would not be expected to pose a health risk to residents.

Future Scenario for the Groundwater Pathway

Review of the groundwater elevation contours and the constituent data over the course of the RI, as presented in the RI Report, indicates that the constituent distribution in groundwater is largely controlled by the groundwater elevations and location relative to Brown Ditch, and there is no indication of dramatic changes in the elevations across the seasons sampled during the RI. Based on the information provided here in Section 2.2.4 and in the RI Report, groundwater flow and groundwater chemistry are not expected to change significantly in the future in the absence of major unforeseen changes. While not required under AOC II, the Respondents voluntarily continued collecting groundwater data since 2007. Five rounds of groundwater and surface water level measurements and sampling have been conducted since then. These data are used to track the extent of elevated B in groundwater and the results demonstrate that the extent of the B is not expanding northward, and in some wells concentrations have decreased (see discussion in Section 2.2.4).

Therefore, while the groundwater data used in the HHRA are representative of the time period over which it was collected, there is no information that would suggest that these conditions would change dramatically in the future, though this was identified as a source of uncertainty in the risk assessment.

Other Potential Impacts on Groundwater Quality

The results of the extensive RI and this HHRA have shown CCB impacts to groundwater above health risk-based screening levels only in localized areas, either in the immediate vicinity of Yard 520 or in limited wetland areas, and that there are a number of other non-CCB-derived constituents present in groundwater in the area, either due to natural or background conditions, or due to other anthropogenic activities.

There are many possible reasons unrelated to CCBs for water to be unpleasant. One of the most common is natural levels of Fe and Mn which are frequently present in groundwater. Naturally occurring levels of Fe and Mn can discolor household items including silverware, laundry, and jewelry, and can clog filters or well points. The presence of B and/or Mo in groundwater is unlikely to impart a taste or color to the water or cause these kinds of problems.

In addition to high levels of Fe and Mn, the RI revealed evidence of other sources of impacts to groundwater in the area that could make water unpleasant, including:

- Septic system discharges;
- Use of road salt in the area;
- A landfill located off Ardendale Road and south of South Railroad Avenue (Pines Landfill owned by Waste Management).

2.3.5 Conclusions of the HHRA

Based on the results of the HHRA as summarized above, risks above 10^{-4} and hazards above one were not identified for any of the receptor scenarios evaluated in the risk assessment with the exception of monitoring wells in the immediate vicinity of Yard 520 and in limited wetland areas.

Based on USEPA's request, COCs have been identified as those constituents with risks greater than 10^{-6} and/or a target endpoint HI of one. These are shown on Tables 1 and 2. Potential risks greater than 10^{-6} were identified for the residential receptor, the outdoor worker, the recreational child, and the recreational fisher. No potential risks above 10^{-6} were identified for the construction worker.

The drinking water risk assessment identified potential risks above 10^{-4} and a hazard index of one in two wells (MW111 and MW122) located outside the MWSE area and in limited wetland areas that are unlikely to be developed, though such development in the future cannot be precluded; and a subset of wells located in close proximity to Yard 520 (MW-3, MW-6, MW-8, MW-10, TW-12, TW-15D, TW-16D, TW-18D), which are located inside the municipal water service area (see Figure 10). Municipal water is available in the area of Yard 520, and it is unlikely that the wetland areas would be developed; however, municipal water could be extended to these areas in the unlikely event they were to be developed in the future. One background well (MW120) and one well in the area serviced by the MWSE impacted by septic systems (MW104) had potential risks above 10^{-6} (in the 10^{-5} range).

2.3.6 Supplemental Risk Evaluations

Post-RI sediment and surface water data have also been collected. A review of the sediment data indicates that the majority of the constituents detected are below the screening levels used in the HHRA and therefore not of concern for the HHRA; concentrations of As and Mn exceed screening levels. However, the concentrations are lower than the Brown Ditch sediment concentrations used in the HHRA, and no further evaluation of post-RI sediment data is warranted.

The post-RI surface water data showed levels of a few constituents greater than screening levels and concentrations greater than those evaluated in the HHRA. A risk assessment for the recreational child and the recreational fisher was conducted using these data and following the methods used in the HHRA. This risk assessment is included in Attachment D of Appendix B.

The evaluation indicates that potential risks associated with potential ingestion of fish containing As are within the low end of USEPA's risk range of 10^{-4} to 10^{-6}, and that the potential hazard index associated with potential ingestion of fish containing Mn is above USEPA's acceptable hazard index of one. The results presented here are based on the maximum constituent values for the two samples. Fish tissue exceedances were not identified in the HHRA based on the RI surface water data, and these results are not of any concern because fishing (and subsequent fish ingestion) is not a common use of Brown Ditch.

It should be noted that Mn is also present in upgradient surface water samples. As provided in the RI Report, Mn was detected in all 44 upgradient surface water samples analyzed for total Mn. Total Mn concentrations in the upgradient samples ranged from 38.4 micrograms per liter (ug/L) to 2,570 ug/L; with an average of 197 ug/L. More recent upgradient surface water samples (SW001 and SW002) are also within this range. The maximum detected concentration used to calculate the potential hazard indices in this risk evaluation of 571 ug/L is within the range of the concentrations detected in upgradient surface water samples.

During the period between the field investigation (2006/2007) and the present (June 2012), two seeps were identified on the western side of Yard 520 along Birch Street. A seep observed in April 2010 was inspected by USEPA and samples were collected by the Respondents for laboratory analysis. These results have been quantitatively evaluated in Attachment E of Appendix B. The total potential carcinogenic risk is well below the low end of USEPA's risk range of 10^{-4} to 10^{-6}, and the total hazard index is well below USEPA's acceptable hazard index of one. Therefore, based on the existing seep data, potential risk due to exposure to seeps that may occasionally occur is insignificant.

2.4 Ecological Risk Assessment

An Ecological Risk Assessment (ERA) was conducted as part of the RI/FS in order to evaluate the potential risks to ecological receptors posed by CCB-derived constituents of potential ecological concern (COPECs) in environmental media within the Area of Investigation. This ERA was conducted in a tiered manner and consisted of a SERA, composed of Steps 1 and 2 in USEPA's ecological risk process, and a COPEC refinement step, representing Step 3a of the process. Step 3a was conducted as part of the uncertainty analysis. The uncertainty analysis also considered a number of other sources of uncertainty which could over- or under-estimate risks to ecological receptors within the Area of Investigation.

2.4.1 Potential ecological receptors and habitats

Potential ecological receptors and habitats within the Area of Investigation were characterized through assessment of available maps, historical information, existing field data, literature results, media concentrations, available biological inventories, regulatory agency information regarding sensitive species and habitats (e.g., threatened and endangered species), etc. A reconnaissance was conducted as part of the SERA to identify local biota and habitats, to focus the ERA on areas of potential ecological habitat within the Pines Area of Investigation and to provide context for the development of the conceptual site model (CSM). This assessment identified several potential aquatic exposure areas (i.e., Brown Ditch, open water pond habitats, and wetland areas associated with Brown Ditch), as well as terrestrial exposure areas where suspected CCBs or CCB-derived constituents may be present.

2.4.2 SERA

The SERA was conducted using the maximum detected concentrations of constituents in sediment, surface water, and suspected CCB samples collected from within the Area of Investigation. COPECs were selected based on comparison of media concentrations against well-established, conservative criteria or screening benchmarks, referred to as ecological screening values (ESVs) and an evaluation of consistency with background. COPECs were further evaluated in conservative food web models designed to assess potential risks to wildlife receptors in aquatic and terrestrial habitats. HQs were calculated as the detected concentration (or dose) divided by the appropriate ESV (or dose-based toxicity reference value [TRV]). The HQ is not a predictor of risk but rather is an index used to indicate whether or not there is potential risk. An HQ equal to or above 1 indicates the potential for adverse effects and further evaluation of potential risk is conducted.

At the end of the SERA, a scientific/management decision point (SMDP) is reached, where a conclusion can be made that (1) the available data indicate there is potential for ecological risk and further evaluation is warranted, (2) the available data indicate either no or low potential for ecological risk and no further work is warranted, or (3) there are data gaps that must be addressed before the presence or absence of risk can be concluded (e.g., additional sampling or analysis). Some exposure pathways for some ecological receptors were eliminated from further consideration at this point. However, other receptors and COPECs warranted further evaluation.

2.4.3 SERA Refinement

Step 3a of the USEPA's ecological risk process was included in the uncertainty section and represents a refinement to the SERA, where COPECs identified in the conservative Steps 1 and 2 evaluations were reviewed considering additional site-specific factors. The refinement of COPECs is designed to address several of the uncertainties in the SERA and present a more site-specific evaluation of potential risks to wildlife receptors. This step considered alternative EPCs, alternative ESVs, including both no observed adverse effect level- (NOAEL) and lowest observed adverse effect level (LOAEL)-based TRVs, and more realistic exposure scenarios for the food web models, including area use factors (AUFs). An additional background evaluation was also conducted for the Brown Ditch sediment dataset to allow consideration of the influence of depositional environments (e.g., percent fines) on the distribution of metals in comparison to the background dataset. Only COPECs, pathways, and receptors retained in this step would be subject to additional evaluation within a Baseline ERA (BERA). The sub-sections below summarize the results of the COPEC refinement for the aquatic and terrestrial exposure areas.

2.4.3.1 Aquatic Environment

The aquatic environment within the Area of Investigation consisted of the Brown Ditch tributary system and several ponds located to the north of the eastern branch of Brown Ditch. Brown Ditch and the pond exposure area were assessed as separate exposure areas in the ERA. Ecological receptors may be exposed to sediment, surface water, groundwater, and/or food items within these environments. The following assessment endpoints were addressed through comparison of media concentrations to appropriate ESVs or through food web modeling:

- Protection and maintenance of freshwater benthic invertebrate populations;
- Protection and maintenance of fish and water column invertebrate communities;
- Protection and maintenance of indigenous wetland plant community;
- Protection and maintenance of indigenous amphibian community; and
- Protection and maintenance of semi-aquatic wildlife receptors (i.e., wildlife receptors expected to forage or breed within the aquatic habitat areas).

Potential impacts to benthic invertebrates, fish and water column invertebrates, wetland plants, and amphibians were evaluated through the comparison of media concentrations (i.e., sediment and surface water) to ecological benchmarks. HQs were generally lower in Brown Ditch than in the pond exposure area. Based on the results of this analysis (Table 3), further evaluation of potential risks to the benthic community, aquatic community, wetland plant community, and amphibian community within Brown Ditch and the pond exposure areas is not warranted.

The exposure pathways evaluated for avian and mammalian wildlife receptors within the aquatic environment included ingestion of prey (i.e., benthic invertebrates, fish), ingestion of plants, inadvertent ingestion of the sediments, and drinking surface water. The refined food web models considered reasonable maximum and average EPCs, NOAEL- and LOAEL-based TRVs, and site-specific AUFs[3]. The Brown Ditch food web model identified two HQs equal to or above 1 under the refined exposure scenario (i.e., average EPC and LOAEL-based TRV) and the pond exposure area

[3] The community-level screening benchmarks and wildlife TRVs used do not generally account for possible synergistic, antagonistic, or additive effects of COPEC mixtures in environmental media. These factors may result in an under-estimate or over-estimate of potential risk.

food web identified two HQs that are less than 1.5, and one HQ that is less than 10 under the refined exposure scenario. The sources of uncertainty in the food web model are expected to over-estimate potential risks. Therefore, further evaluation of potential risks to wildlife in the aquatic exposure areas is not warranted.

2.4.3.2 IDNL

The IDNL is considered a significant regional ecological resource so the evaluation of potential risks to receptors in the IDNL is discussed separately from the other aquatic exposure areas. Groundwater within the Area of Investigation generally flows towards and into Brown Ditch which eventually flows into the IDNL. Once in the IDNL, the ditch takes a turn to the northeast and flows into Kintzele Ditch, which then flows to Lake Michigan. Brown Ditch is not known to contain economically, recreationally, or ecologically sensitive species and communication with IDNR Division of Fish and Wildlife staff (Tom Bacula) indicates that within the IDNL, Brown Ditch might be expected to contain minnows, shiners, bullhead, carp, chubs, suckers, bluegill, bass, and possibly bowfin.

The sediment sample collected from Brown Ditch in closest proximity to the IDNL (SW027) indicates that low levels of COPECs are present within the ranges observed within the upgradient data set. Concentrations of COPECs detected in SW027 were below the screening level ESVs, except for Ba and Se which were below the refined ESVs. Concentrations of COPECs within IDNL sediments would likely be lower than the levels observed in SW027.

The surface water sample collected from Brown Ditch in closest proximity to the IDNL (SW009) indicates that low levels of COPECs are present within the ranges observed within the upgradient data set. With the exception of Fe, concentrations of COPECs detected in SW009 were all below the refined ESVs for the protection of aquatic life. Surface water concentrations of all wetland COPECs, except Fe, are below levels associated with phytotoxicity.

Concentrations of all root zone groundwater COPECs in the monitoring wells closest to the IDNL (MW123 and MW110) are below the associated ESVs, indicating that impacts to plants in the IDNL are not expected.

Groundwater within the Area of Investigation generally flows towards and into Brown Ditch which eventually flows into the IDNL. A review of the groundwater elevation contours over the course of the RI as well as the constituent data, as presented in the RI Report (AECOM, 2010), indicates that the constituent distribution in groundwater is largely controlled by the groundwater and surface water elevations, and there is no indication of dramatic changes in the elevations across the seasons sampled during the RI. Significant concentrations of CCB-related constituents are not currently migrating in groundwater towards IDNL, and based on the information provided in the RI Report, are not expected to migrate there in the future in the absence of major unforeseen changes to the groundwater flow system.

These results do not indicate sediment, surface water, or groundwater transport of CCBs into the IDNL at levels that would result in significant adverse impacts to aquatic receptors, benthic receptors, or aquatic or wetland plants in the IDNL.

2.4.3.3 Terrestrial Environment

The evaluation of the terrestrial environment within the Area of Investigation focused on areas of overlap between terrestrial ecological habitats and locations where CCB materials were placed. Ecological receptors may be exposed directly to suspected CCB containing materials or to food items within these environments. The following assessment endpoints were addressed through comparison of media concentrations to appropriate ESVs or through food web modeling:

- Protection and maintenance of indigenous terrestrial plant and soil invertebrate communities in upland habitat areas; and
- Protection and maintenance of terrestrial wildlife receptors (i.e., wildlife receptors expected to forage or breed within upland habitat areas).

The exposure pathway evaluated for terrestrial plants and invertebrates included direct contact with CCB-derived COPECs in soil. This pathway was evaluated through the comparison of suspected CCB concentrations to ecological benchmarks. This evaluation indicated that, in general, risks to these receptors are expected to be acceptable and similar to risks in areas outside the Area of Investigation. Some elevated HQs were noted (B, Cr, and V for plants; Cr and Fe for earthworms), although the confidence in the ESVs resulting in these HQs is low. In addition, the suspected CCB dataset included deep samples that are likely not in contact with soil invertebrates or plants and the dataset is focused on CCB-materials (un-sampled areas may contain more of a mix of CCBs and native soils with lower levels of COPECs). Based on the results of the CCB visual inspections conducted under the RI, an evaluation was conducted of areas of potential ecological exposure (see Appendix Q of the SERA Report) and it was determined that CCBs made up no more than 45% of the ground surface material and in some cases covered less than 25% of the ground surface area. Thus, the assumption that 100% of the soil exposure for terrestrial receptors comes from CCBs over-estimates potential risks.

The potential exposure of avian and mammalian receptors to COPECs from soil and food items (via bioaccumulation) was evaluated in a food web model. The refined food web model considered reasonable maximum and average EPCs, NOAEL- and LOAEL-based TRVs, and site-specific AUFs. The food web model identified four HQs above 1 but below 4 under the refined exposure scenario (i.e., average EPC and LOAEL-based TRV) for the evaluation of risks to the terrestrial wildlife community within the Area of Investigation due to exposure to CCB-related COPECs. The potential risks to birds due to the ingestion of CCB-containing materials used as grit was also conducted. This food web model identified two HQs above 1 but below 3 under the refined exposure scenario (i.e., average EPC and LOAEL-based TRV). Several conservative assumptions in the terrestrial food web model (e.g., 100% bioavailability, use of suspected CCB dataset to represent surface soil exposure) and the grit ingestion evaluation are likely to over-estimate potential risks to wildlife.

The community-level screening benchmarks and wildlife TRVs used do not generally account for possible synergistic, antagonistic, or additive effects of COPEC mixtures in environmental media. These factors may result in an under-estimate or over-estimate of potential risk.

Based on the results of this analysis (Table 3), further evaluation of potential risks to terrestrial receptors is not warranted.

2.4.4 Conclusions of ERA

At the completion of the SERA and the Refined SERA, an SMDP is reached where a conclusion can be made that (1) the available data indicate there is potential for ecological risk and further evaluation is warranted, (2) the available data indicate either no or low potential for ecological risk and no further work is warranted, or (3) there are data gaps that must be addressed before the presence or absence of risk can be concluded (e.g., additional sampling or analysis). To reach the SMDP, the risk assessment team communicates the results of the ERA to the risk manager and the risk manager determines whether the information available is adequate to make a risk management decision regarding the need to proceed with further, in-depth, evaluations.

Based on the results of the ERA conducted for the Pines Area of Investigation, the available data indicate no or low potential for ecological risk to aquatic and terrestrial receptors within the Area of Investigation.

3.0 Preliminary Evaluation of ARARs

This section presents potential ARARs for the Pines Area of Investigation. As per AOC II (Section IV, 10), the Respondents are required to conduct all RI/FS activities for the Pines Area of Investigation in accordance with CERCLA, the National Contingency Plan (NCP), and all applicable USEPA guidance, policies, and procedures. Further, Task 6 in the SOW attached to AOC II (i.e., Identification of RAOs) requires the Respondents to provide a preliminary evaluation of ARARs for the Area of Investigation. Thus, potential ARARs, as defined in CERCLA, the NCP and other USEPA guidance, are presented herein for the Pines Area of Investigation.

3.1 Overview of ARARs

ARARs are federal and state human health and environmental requirements that are used to help define RAOs, identify sensitive land areas or land uses, develop remedial alternatives, and direct cleanup (if needed). Section 121(d) of CERCLA and the NCP require that on-site remedial actions attain Federal environmental ARARs or more stringent State environmental ARARs upon completion of the remedial action, or otherwise formally waive the ARARs.

The NCP defines two types of ARARs: applicable requirements, and relevant and appropriate requirements.

1. "Applicable" requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, or other circumstance found at a CERCLA site. Only state standards that are more stringent than federal standards, have been promulgated at the state level (i.e., are legally enforceable and generally applicable), and have been identified by the state in a timely manner may be applicable.

2. "Relevant and appropriate" requirements are those cleanup standards, standards of control, and other substantive requirements under federal and state environmental and facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, or remedial action, address situations sufficiently similar to those encountered at the CERCLA site so that their use is well suited to the particular site. As with applicable requirements, only state standards that are more stringent than federal standards, have been promulgated at the state level (i.e., are legally enforceable and generally applicable), and have been identified by the state in a timely manner may be relevant and appropriate.

"Applicability" is a legal determination of jurisdiction of existing statutes and regulations, whereas "relevant and appropriate" is a site-specific determination of the appropriateness of existing statutes and regulations. Therefore, relevant and appropriate requirements allow flexibility not provided by applicable requirements in the final determination of cleanup levels. Relevant and appropriate requirements apply only to on-site response actions, while applicable requirements are universally applicable.

Other requirements "to be considered" (TBC) are federal and state non-promulgated advisories or guidance that are not legally binding and do not have the status of potential ARARs (i.e., they have not been promulgated by statute or regulation). However, if there are no specific ARARs for a constituent or site condition, then guidance or advisory criteria should be identified and used to ensure the protection of human health and the environment. For example, TBC advisories, criteria, or guidelines available in risk assessment guidance can be used to set cleanup targets where no ARARs address a particular situation.

Under the description of ARARs set forth in the NCP and the Superfund Amendments and Reauthorization Act, state and federal ARARs are categorized as:

- Chemical-specific: governing the extent of cleanup with regard to specific constituents;
- Location-specific: governing site features such as wetlands, floodplains, and sensitive ecosystems, and pertaining to existing natural and manmade site features such as historical or archaeological sites; and
- Action-specific: pertaining to the proposed site remedies and governing the implementation of the selected remedy.

ARARs for the Pines Area of Investigation have been identified based on a review of federal and State of Indiana requirements that regulate circumstances similar to those found in the Area of Investigation.

3.2 Chemical-Specific ARARs

Chemical-specific ARARs are typically health-based or risk-based numerical values or methodologies that establish site-specific acceptable constituent concentrations or amounts. They can dictate the extent of remediation by providing either actual remediation goals or the basis for calculating such goals. Chemical-specific ARARs for the Pines Area of Investigation are summarized on Table 4, and are described below.

3.2.1 Groundwater

The federal National Primary Drinking Water Regulations established under the Safe Drinking Water Act (SDWA) provide maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs) for selected organic and inorganic chemicals in groundwater. MCLs are potentially relevant and appropriate during a CERCLA cleanup for groundwater that is a current or potential source of drinking water (USEPA, 1991a). MCLs are only applicable where groundwater undergoing a CERCLA remedial action is delivered through a public water supply system, if that system has at least 15 service connections or serves at least 25 year-round residents. As stated by the USEPA in its CERCLA Compliance with the SDWA Fact Sheet (USEPA, 1991a), CERCLA projects rarely treat tap water, so there will be few instances where MCLs are applicable for groundwater cleanup.

MCLGs are non-enforceable health goals for public water supply systems (they are set at levels that would result in no known or expected adverse health effects with an adequate margin of safety). Under the NCP, the USEPA requires that MCLGs set at levels above zero (i.e., non-zero MCLGs) be considered a potential ARAR in instances where MCLs have not been established for a particular compound of concern (USEPA, 1991a).

To determine the status of MCLs and MCLGs as ARARs for the Pines Area of Investigation, groundwater classification in the Area of Investigation was examined. Indiana’s Groundwater Quality Standards (GQS) (327 IAC 2-11) provide groundwater protection to wells and allow for the classification of groundwater. The rule states that all groundwater of the state shall be classified as “drinking water class” groundwater unless it is classified as: “limited class” groundwater or “impaired drinking water class” groundwater. In the Pines Area of Investigation, the groundwater has not been classified as limited class or impaired drinking water class, thus the groundwater is considered drinking water class groundwater. It is noted that a request for reclassification of the groundwater can be made, but until that occurs, groundwater is considered drinking water class.

Groundwater in the Area of Investigation is tapped by some households for potable use (other households have access to a municipal water supply). However, groundwater is typically tapped for potable use on an individual basis, and, to our knowledge, a single well does not serve more than 25 year-round residents. Thus, for the Pines Area of Investigation, the federal MCLs and non-zero MCLGs are not *applicable* (as explained above), and thus are only considered *relevant and appropriate* for the Pines Area of Investigation.

As stated above, state standards that are more stringent than their respective federal standards are also ARARs. Thus, Indiana’s GQS regulations (327 IAC 2-11) were examined. The GQS were promulgated to maintain and protect the quality of Indiana’s groundwater, and ensure that exposure to the groundwater will not pose a potential threat to human health, any natural resource, or the environment. These standards (327 IAC 2-11(e)) state that no person shall cause the groundwater in a drinking water supply well to have a contaminant concentration that creates one (1) or more of the following:

- An exceedance of the numeric criteria established in the Indiana GQS regulations for drinking water class groundwater;
- A level sufficient to be acutely or chronically toxic, carcinogenic, mutagenic, teratogenic, or otherwise injurious to human health based on best scientific information;
- An exceedance of one or more of the following indicator levels: chloride at 250 mg/L, sulfate at 250 mg/L, total dissolved solids at 500 mg/L, or total coliform bacteria at nondetect; or
- Renders the well unusable for normal domestic use.

These standards apply at a drinking water supply well, which is defined by the GQS as a bored, drilled, or driven shaft or a dug hole that meets the following:

- Supplies ground water for human consumption.
- Has a depth greater than its largest surface dimension.
- Is not permanently abandoned.

Given the above definitions, the Indiana GQS are *applicable* to drinking water wells in the Area of Investigation (i.e., no other service connection or population served minimums are denoted in the GQS).

A final chemical-specific ARAR identified for groundwater included the Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40 CFR §192.12). While these regulations are only applicable to the control of residual radioactive material at designated processing or depository sites under Section 108 of the Uranium Mill Tailings Radiation Control Act (UMTRCA), USEPA has suggested (and provided guidance[4]) where these criteria should be considered relevant and appropriate at other CERCLA sites, and, as such are considered so for the Pines Area of

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[4] http://www.epa.gov/superfund/health/contaminants/radiation/pdfs/umtrcagu.pdf

Investigation. The regulations identify a standard of 5 pCi/g above background for use of assessing the combined levels of Ra-226 and Ra-228.

One TBC criterion was identified for the Pines Area of Investigation. The USEPA RSLs are developed by the USEPA using risk assessment guidance for the USEPA Superfund program. They are risk-based concentrations derived from standardized equations combining exposure information assumptions with USEPA toxicity data. The RSLs are generic; they are calculated without site-specific information.

An RSL is typically used for initial site "screening." RSLs are not de facto cleanup standards and should not be applied as such. The RSLs' role in site "screening" is to help identify areas, constituents, and conditions that require further evaluation at a particular site. Generally, at sites where constituent concentrations fall below RSLs, no further action or study is warranted under the Superfund program. Constituent concentrations above the RSLs would not automatically trigger a response action; however, exceeding a RSL suggests that further evaluation of the potential risks by site constituents is appropriate. As such, RSLs were used in the screening step of the HHRA for the Pines Area of Investigation. RSLs have also been included as a TBC for the Pines Area of Investigation, in the consideration of establishing RAOs.

3.2.2 Surface Water

Federal and state regulations also provide potential ARARs for surface waters. The State of Indiana has promulgated Surface Water Quality Standards (SWQS) for surface waters within the Great Lakes System (327 IAC 2-1.5) and waters not within the Great Lakes System (327 IAC 2-1). Surface waters within the Pines Area of Investigation are within the Great Lakes System, thus 327 IAC 2-1.5 apply. These regulations state that the chemical, physical, and biological integrity of the waters within the Great Lakes system shall be maintained or restored; thus, the discharge of toxic substances in certain amounts is prohibited, and persistent and bioaccumulating toxic substances shall be reduced or eliminated (these are further discussed below). Further, these regulations specify (under 327 IAC 2-1.5-5) that:

- All surface waters of the state within the Great Lakes system are designated for full-body contact recreation;
- All surface waters shall be capable of supporting a well-balanced, warm water aquatic community; and
- All surface waters shall be capable of supporting put-and-take trout fishing.

For all surface waters of the state within the Great Lakes system, existing instream water uses and the level of water quality necessary to protect existing uses shall be maintained and protected. Thus, all high quality waters designated under this rule shall be maintained and protected in their present high quality without degradation, and, high quality waters designated as an outstanding national resource water (such as waters of national and state parks and wildlife refuges and waters of exceptional recreational or ecological significance) shall be maintained and protected in their present high quality without degradation. These last qualifiers apply to certain waters within the Pines Area of Investigation as follows:

- Kintzele Ditch from Beverly Drive downstream to Lake Michigan is designated as salmonid waters and shall be capable of supporting a salmonid fishery; and
- All waters incorporated in the IDNL are designated as an "Outstanding state resource waters."

The minimum surface water quality criteria that apply to waters within the Great Lakes system are described in 327 IAC 2-1.5-8. This rule states that, for all surface waters within the Great Lakes system, concentrations of toxic substances shall not exceed the criterion maximum concentration (CMC), which is an estimate of the highest concentration of a material in the water column to which an aquatic community can be exposed briefly without resulting in an unacceptable effect) or the secondary maximum concentration (SMC), which is an estimate of the highest concentration of a material in the water column to which an aquatic community can be exposed briefly without resulting in an unacceptable effect) outside the zone of initial dilution, or the final acute value (which is equivalent to 2*CMC or 2*SMC) in the undiluted discharge. For certain substances, a CMC is established and set forth in Table 8-1 of the Rule. For substances for which a CMC is not specified in Table 8-1, a CMC shall be calculated using the Tier I procedures provided in Section 11 of the rule, or if the minimum data requirements to calculate a CMC are not met, an SMC shall be calculated using the Tier II procedures provided in Section 12 of the rule. It is important to note that numeric Tier I and Tier II values are not provided in the rules; rather, the methodology for calculating such values is provided. Thus, the water quality standards established in Table 8-1 of the rule and the methodology for calculating Tier I and Tier II values are *applicable* to all waters of the state within the Great Lakes system.

There are also federal rules for surface water, including the federal Water Quality Criteria (WQC), which are non-enforceable guidelines that set concentrations of chemicals that are considered adequate to protect human health (ingestion of contaminated drinking water and/or fish) and aquatic organisms (USEPA, 1990). Federal WQC can be relevant and appropriate requirements under CERCLA if a particular circumstance exists that the WQC were designed to protect (e.g., in the Pines Area of Investigation, protection of aquatic organisms in surface water would be a scenario in which the WQC are designed to protect), unless the state has promulgated water quality standards for the specific pollutants and water body at the site. Because the State of Indiana has promulgated surface water standards, the federal WQC are not ARARs for the Pines Area of Investigation.

3.2.3 Soil and sediment

Currently, there are no promulgated federal or state chemical-specific ARARs that provide limits for the concentration of constituents in soil or sediment. Thus, no additional chemical-specific ARARs have been identified for soil and sediment in the Pines Area of Investigation. The State of Indiana's Risk Integrated System of Closure (RISC) program (IDEM, 2001) does provide soil screening levels[5]. This program was evaluated for potential inclusion as an ARAR for the Pines Area of Investigation, but was ultimately not deemed an ARAR. The RISC program was developed to promote consistency in the closure of impacted soil and groundwater sites in the State. The RISC guidance manual describes how to achieve consistent closure of impacted soil and groundwater sites using existing IDEM programs. The RISC program is considered by Indiana a non-rule policy document, which means that it does not have the full force and effect of law, and thus cannot be an ARAR for the Pines Area of Investigation. Further, RISC only applies to impacted industrial, commercial, or residential sites that are currently covered under existing IDEM programs. The Pines Area of Investigation is a federal Superfund Alternative site, and thus is not under a state program. However, at the request of the USEPA, the RISC program has been identified as TBC criteria, and is listed as such on Table 4.

[5] Note that these are screening levels, and are not fixed as clean-up levels; soil screening levels can be adjusted based on a site-specific risk assessment.

3.3 Location-Specific ARARs

Location-specific ARARs govern site features (e.g., wetlands, floodplains, wilderness areas, and endangered species) and manmade features (e.g., places of historical or archeological significance). These ARARs impose restrictions on the conduct of activities based on the site's particular characteristics or locations. Location-specific ARARs for the Pines Area of Investigation are summarized on Table 5, and are described below.

Requirements pertaining to wetlands and floodplains are identified as potential ARARs for the Pines Area of Investigation. Wetland-related requirements have been identified as potential ARARs because of the likelihood that wetlands exist. Floodplain-related requirements have also been identified as potential ARARs.

Other location-specific ARARs include requirements pertaining to threatened or endangered species. Indiana requirements pertaining to Restricted Waste Sites also are provided.

3.4 Action-specific ARARs

Action-specific ARARs are technology- or activity-based limitations affecting remedial actions. Action-specific ARARs generally set performance or design standards, controls, or restrictions on particular types of activities. The discussion of action-specific ARARs for the Pines Area of Investigation is postponed until the stage of the remedial process where remedial alternatives are identified and reviewed.

4.0 Remedial Action Objectives

AOC II and its attachment, the SOW, require the Respondents to identify RAOs (Task 6) as a component of the FS process, based on the results of the RI, HHRA, and ERA. Under the AOC and SOW, RAOs specific to the Pines Area of Investigation should be identified considering the following:

- Prevention or abatement of unacceptable risks (current and/or reasonable future) to nearby human populations (including workers), animals, or the food chain from hazardous substances, pollutants, or constituents associated with CCBs.
- Prevention or abatement of unacceptable risks (current and/or reasonable future) associated with CCBs due to exposures including drinking water supplies and ecosystems.
- Acceptable constituent levels, or range of levels, for appropriate site-specific exposure routes.
- Mitigation or abatement of other situations or factors that may pose threats to public health, welfare, or the environment.
- A preliminary evaluation of ARARs.

To address potential risks associated with CCB-derived constituents in drinking water, the Respondents conducted a Response Action which included extending municipal water from Michigan City to replace private wells as a drinking water source. Figure 3 shows the area which is currently served by the municipal water system. The Respondents provided municipal water to more than 290 residences and businesses in this area. This cost of this remedial action was $5,255,000, including the provision of bottled water to residents outside of the MWSE area who have requested this service. Note that the Respondents voluntarily chose to provide the extended municipal water service identified under the Amendment to AOC I, and that this response occurred well in advance of the conclusion of the RI/FS process. The results of the RI and the HHRA have shown that the extent of the municipal water service has been sufficient to protect residents from exposure to unacceptable levels of CCB-derived constituents in groundwater. Therefore, this Response Action has already addressed the primary remedial action objective, to prevent human exposure to unacceptable levels of CCB-derived constituents in drinking water. In addition, Yard 520 was closed between 2004 and 2007, and the cost for this remedy was $1,524,000. Additional RAOs have been identified for potential pathways not addressed by the original Response Action, as detailed below.

Based on the results of the HHRA as summarized in Section 2.0, risks above 10^{-6} or a hazard index of one were not identified for any of the receptor scenarios evaluated in the risk assessment for groundwater with the exception of groundwater in the immediate vicinity of Yard 520 (represented by wells MW-3, MW-6, MW-8, MW-10, TW-12, TW-15D, TW-16D, AND TW-18D) and in limited wetland areas (represented by wells MW111 and MW122), where there is currently no complete pathway to potential receptors. One background well (MW120) and one well in the area serviced by the MWSE impacted by septic systems (MW104) had potential risks above 10^{-6} (in the 10^{-5} range). The drinking water risk assessment identified potential risks above 10^{-4} and a hazard index of one in only two wells (MW111 and MW122) located outside the water service area and in wetland areas that are unlikely to be developed, though such development in the future cannot be precluded. The drinking water risk assessment also identified potential risks above 10^{-4} and/or a hazard index of one in a subset of wells located in close proximity to Yard 520, which are located within the municipal water service area. Based on these considerations, the following RAO was identified to address potential migration from CCBs to groundwater:

RAO 1: Reduce the volume, toxicity, and/or mobility of CCB- and site-related COCs in the areas represented by those wells identified with COCs greater than background levels that are unaffected by site-related contamination and with risks within and/or above USEPA's target risk range of 1E-06 to 1E-04 and a target endpoint specific hazard index of 1, including, but not limited to MW-3, MW6, MW-8, MW-10, TW-12, TW-15D, TW-16D, TW-18D, MW111, and MW122.

The preliminary evaluation of ARARs indicates that all groundwater of the State of Indiana is classified as "drinking water class" groundwater unless it is classified as: "limited class" groundwater or "impaired drinking water class" groundwater. In the Pines Area of Investigation, the groundwater has not been classified as limited class or impaired drinking water class, thus the groundwater is considered drinking water class groundwater. The installation of the MWSE has been sufficient to protect residents from exposure to unacceptable levels of CCB-derived constituents in groundwater. Although only a small area within the MWSE area has the potential for drinking water risk, use of groundwater as drinking water in the MWSE area should be eliminated for the future (that is, installation of a drinking water well in the MWSE area should not be permitted). Based on these considerations, the following RAO was identified:

RAO 2: Prevent the installation of private wells and use of groundwater for drinking in all areas where COC concentrations are greater than background levels that are unaffected by site-related contamination and are associated with risks within and/or above USEPA's target risk range of 1E-06 to 1E-04 and a target endpoint specific hazard index of 1.

The following RAO is based on consideration of ARARs for groundwater and the risk-based foundation of the CERCLA program:

RAO 3: Restore groundwater to achieve and maintain ARARs including federal and state drinking water standards and ambient water quality standards,, protective levels (corresponding to risks within and/or above USEPA's target risk range of 1E-06 to 1E-04 and a target endpoint specific hazard index of 1) and/or background levels that are unaffected by site-related contamination for CCB-related constituents within a timeframe that is reasonable considering practicable response action alternatives.

The following RAOs are based on consideration of ARARs for solid media and the risk-based foundation of the CERCLA program:

RAO 4: Reduce or eliminate potential exposure to CCB- and site-related COC concentrations at or near the ground surface greater than background levels that are unaffected by site-related contamination and associated with risks within and/or above USEPA's target risk range of 1E-06 to 1E-04 and a target endpoint specific hazard index of 1.

RAO 5: Monitor groundwater upgradient and downgradient of CCB fill areas to demonstrate remedial progress and determine when potential beneficial uses of groundwater (drinking and discharge to surface water) are met (i.e., achieving and maintaining ARARs including federal and state drinking water standards and ambient water quality standards, protective levels (corresponding to risks within and/or above USEPA's target risk range of 1E-06 to 1E-04 and a target endpoint specific hazard index of 1) and/or background levels that are unaffected by site-related contamination for CCB-related constituents).

Based on the results of the ERA conducted for the Pines Area of Investigation, the available data indicate no or low potential for ecological risk to aquatic and terrestrial receptors within the Area of Investigation. Therefore, the Respondent's risk assessment team recommends no further evaluation of potential risks to ecological receptors at this time because the ERA indicates that current ecological risks are either low or almost entirely absent. However, an RAO has been identified to address the potential future migration of CCB-derived constituents in groundwater northward into IDNL at concentrations of significance:

RAO 6: Provide for the long-term protection of the IDNL from groundwater, surface water and sediment contamination originating from CCBs and site-related COCs in the Area of Investigation.

5.0 General Response Actions

In accordance with the SOW (Tasks 7.1 and 7.2), this Section identifies general response actions and areas within the Pines Area of Investigation to which the general response actions may apply.

5.1 Identification of General Response Actions

General response actions are those actions that will satisfy the RAOs. General response actions may include such remedial actions or technologies as treatment, containment, disposal, institutional controls or a combination of these (USEPA, 1988). The categories of potential general response actions for the Pines Area of Investigation are:

- No action (a required response action for CERCLA)
- Land Use Controls
- Containment
- *Ex Situ* Removal/Treatment
- *In Situ* Treatment

5.2 Areas within the Pines Area of Investigation to which the General Response Actions Apply

RAOs have been developed for CCB-related constituents in groundwater and soil within the Area of Investigation.

As detailed in Section 4.0, the HHRA did not identify groundwater risks above 10^{-6} and a hazard index of one for any of the receptor scenarios evaluated, with the exception of groundwater in the immediate vicinity of Yard 520 (represented by wells MW-3, MW-6, MW-8, MW-10, TW-12, TW-15D, TW-16D, and TW-18D) and in limited wetland areas (represented by wells MW111 and MW122), where there is currently no complete pathway to potential receptors. One background well (MW120) and one well in the area serviced by the MWSE impacted by septic systems (MW104) had potential risks above 10^{-6} but below 10^{-4}. The drinking water pathway evaluation identified potential risks above 10^{-4} and a hazard index of one in only two wells (MW111 and MW122) located outside the MWSE and in wetland areas that are unlikely to be developed (but development in the future cannot be entirely ruled out). The drinking water pathway evaluation also identified potential risks above 10^{-4} and/or a hazard index of one in a subset of wells located in close proximity to Yard 520, which are located within the MWSE. These areas are shown on Figure 10.

Potential risks within the USEPA risk range of 10^{-4} to 10^{-6} were identified for suspected CCBs. Figure 4 depicts the information compiled about the potential locations of suspected CCBs at the ground surface within the Area of Investigation based on the visual inspections and the information presented in the RI Report (AECOM, 2010). It is clear, based on historical evidence and visual inspection, that CCBs were used as fill only in a subset of the Area of Investigation. Soil samples for chemical and radiological analysis were not collected from individual residential properties, and soil samples (possibly including some percentage of CCBs) have not been collected across much of the Pines Area of Investigation.

6.0 Identification and Screening of Remedial Alternatives

The approach and rationale leading to the development of remedial alternatives applicable to the Pines Area of Investigation are presented in this chapter. The approach consists of identifying technologies appropriate for the Area of Investigation and screening those technologies for effectiveness, implementability, and cost factors (Section 6.1). The rationale for selection or elimination of technologies is discussed in the screening analysis. From the technologies that pass the screening step, remedial alternatives that would achieve the RAOs are identified, and screened, as necessary (Section 6.2). Finally, the remedial alternatives that will be carried forward to the detailed analysis for the FS are summarized (Section 6.3).

6.1 Identification and Screening of Remedial Technologies

Potential remedial technologies applicable to CCB-related COCs in soil and groundwater in the Pines Area of Investigation are identified and described in Table 6. This table identifies categories (or types) of remedial action technologies appropriate for each media (e.g., general response actions such as No Action, Institutional Controls, Containment, Treatment). It also identifies the basic process options and example technologies that exist within each category, and provides a brief description of each process option.

The screening of remedial technologies is provided in Table 7. Remedial technologies are screened based on an evaluation of effectiveness, implementability and cost factors (as suggested in the USEPA Guidance Manual for Conducting RI/FS at Superfund Sites (USEPA, 1988)). A tiered approach to evaluation of these factors was taken: each identified technology was first reviewed for its effectiveness to achieve the RAOs for the Pines Area of Investigation; if that technology was deemed ineffective, it was not reviewed further. If a technology was deemed effective, then an evaluation of implementability and cost factors was conducted.

6.2 Assemble Remedial Alternatives

Remedial technologies that pass the screening step have been assembled into remedial alternatives that address the RAOs for the Pines Area of Investigation. Together, these remedial alternatives represent a range of technologies or combinations of technologies to address CCB-related COCs within the Area of Investigation.

Table 8 shows how the remedial technologies that pass the screening step were formulated into groundwater and soil remedial alternatives for the Pines Area of Investigation. These alternatives are further described below, and in Tables 9A and 9B (groundwater and soil, respectively).

Additional screening of remedial alternatives (beyond the screening conducted for the remedial technologies) is necessary only when there are many feasible alternatives available. This is not the case for the Pines Area of Investigation, and each of the technologies that pass the screening step was retained within a remedial alternative.

6.2.1 Groundwater Alternatives

Five groundwater alternatives have been identified and are presented below as GW Alterative 1 through GW Alternative 5; these are summarized in Table 9A. It should be noted that most of these alternatives would require property acquisition and/or pilot studies to be completed prior to implementation.

6.2.1.1 GW Alternative 1: No Further Action

In accordance with the NCP, the no action remedy is used as a baseline for comparison for the other remedial alternatives; however, the no action remedy is also an appropriate remedy for consideration. At the Pines Area of Investigation, two response actions have already been implemented: installation of the MWSE and closure of Yard 520, for a total cost of $6,749,000; thus, Alternative 1 is considered a *No Further Action* remedy rather than simply a *No Action* remedy.

The Respondents completed a major construction project to extend Michigan City's municipal water service from Michigan City to designated areas in the Town of Pines.

The agreement to conduct this work was documented in two Administrative Orders on Consent: AOC I, dated February 2003 (AOC 1, 2003), and AOC I, amended, dated April 2004 (AOC 1, Amended, 2003). The areas that received municipal water service are identified in Figure 3. In all, the Respondents provided municipal water to more than 290 residences and businesses. The completion of the MWSE has eliminated potential use of groundwater for drinking in the Area of Investigation within the areas shown in Figure 3. Costs for the MWSE project were $5,255.000.

Yard 520 is a closed permitted Restricted Waste Facility and is regulated by IDEM. Post-closure plans approved by IDEM provide the regulatory scope of requirements for Yard 520. Costs for the closure of Yard 520 were $1,524,000.

6.2.1.2 GW Alternative 2: Land Use Controls

This alternative includes the following components, which have already been implemented in the Pines Area of Investigation and are described above for GW Alternative 1:

- MWSE; and
- Closure of Yard 520.

This alternative also includes Land Use Controls in the form of a groundwater ordinance, and deed restrictions. These controls are described in Table 9A.

A monitoring program is included as a component of this alternative, and would provide an effective means to monitor conditions within the Area of Investigation to evaluate compliance with RAOs.

6.2.1.3 GW Alternative 3: Monitored Natural Attenuation

This alternative includes the following components, which have already been implemented in the Pines Area of Investigation and are described above for GW Alternative 1:

- MWSE; and
- Closure of Yard 520.

This alternative also includes the following components, which are described on Table 9A:

- Land Use Controls in the form of a groundwater ordinance, deed restrictions; and
- Monitored Natural Attenuation.

The monitoring program included under GW Alternative 2 would be implemented, and supplemented to include evaluation of relevant parameters to document naturally occurring processes that reduce mass, toxicity, mobility, volume, or concentrations of constituents in an attempt to meet the expectation of restoring the aquifer to beneficial use. It also would provide an effective means to monitor groundwater conditions within the Area of Investigation to evaluate compliance with RAOs.

6.2.1.4 **GW Alternative 4: Active Groundwater Treatment**

This alternative includes the MWSE and the closure of Yard 520, which have already been implemented in the Pines Area of Investigation and are described above for GW Alternative 1:

This alternative also includes the following components, which are described on Table 9A:

- Land Use Controls in the form of a groundwater ordinance, deed restrictions; and
- Active groundwater treatment.

Active groundwater treatment would include groundwater extraction and treatment, hydraulic or reactive barriers, or phytoremediation. Active groundwater treatment would be implemented to reduce CCB-derived COCs in groundwater within the zone of capture in an attempt to meet the expectation of restoring the aquifer to beneficial use.

6.2.1.5 **GW Alternative 5: Passive Groundwater Treatment**

This alternative includes the MWSE and the closure of Yard 520, which have already been implemented in the Pines Area of Investigation and are described above for GW Alternative 1.

This alternative also includes the following components, which are described on Table 9A:

- Land Use Controls in the form of a groundwater ordinance, deed restrictions; and
- Passive groundwater treatment.

Passive groundwater treatment would include the installation of physical barriers (e.g., bentonite-clay slurry or sheet pile wall) to control the migration of CCB-related constituents in groundwater. Passive groundwater treatment would be implemented in an attempt to meet the expectation of restoring the aquifer to beneficial use outside the area of containment.

6.2.2 Soil Alternatives

Four soil alternatives have been identified and are presented below as Soil Alternative 1 through Soil Alternative 4; these are summarized in Table 9B. It should be noted that property acquisition may be required for most of these alternatives.

6.2.2.1 **Soil Alternative 1: No Further Action**

In accordance with the NCP, the no action remedy is used as a baseline for comparison for the other remedial alternatives; however, the no action remedy is also an appropriate remedy for consideration. At the Pines Area of Investigation, a response action has already been implemented: closure of Yard 520; thus, Soil Alternative 1 is considered a No Further Action remedy rather than simply a No Action remedy.

Yard 520 is a closed permitted Restricted Waste Facility and is regulated by IDEM. Post-closure plans approved by IDEM provide the regulatory scope of requirements for Yard 520. Costs for the closure of Yard 520 were $1,524,000.

6.2.2.2 Soil Alternative 2: Land-Use Controls

This alternative includes closure of Yard 520, which has already been implemented in the Pines Area of Investigation and is described above for Soil Alternative 1.

This alternative would also include land use controls, if appropriate, to control the risk from exposure to surficial soils.

6.2.2.3 Soil Alternative 3: CCB Removal

This alternative includes closure of Yard 520, which has already been implemented in the Pines Area of Investigation and is described above for Soil Alternative 1. This alternative would also involve sampling and removal/replacement (where warranted, i.e., where concentrations are above background, within or above the target risk range of 10^{-6} to 10^{-4} and a target endpoint specific HI of 1, and where suitable fill can be obtained that can be shown to have concentrations below background, within or below the target risk range, and below concentrations in the material it is replacing) of surficial soils in residential yards, schools, and playgrounds.

This alternative could involve removal of surficial CCBs not just from residential locations, but also from vacant and undeveloped land within the Area of Investigation. Removal of surficial CCBs would be implemented to achieve a risk level within the 10^{-4} to 10^{-6} risk range or target hazard index of 1 or background.

6.2.2.4 Soil Alternative 4: Capping

This alternative includes closure of Yard 520, which has already been implemented in the Pines Area of Investigation and is described above for Soil Alternative 1. Capping may be also considered as a remedy for specific areas outside of Yard 520, as warranted. The materials used for capping would need to be shown to have concentrations of constituents below background, within or below the target risk range, and below the concentrations in the material it is covering.

This alternative mitigates direct contact exposure to CCB related constituents and controls their mobilization due to wind or precipitation/runoff, and migration to groundwater. Deed restrictions would be required to control capped areas.

6.2.3 Additional Data Evaluation and Review

Prior to completing the selection analysis for CCB-related COCs at the ground surface within the Area of Investigation, additional data collection, evaluation, and review is necessary. Thus, the Respondents are deferring selection analysis for CCB-related COCs at the ground surface within the Area of Investigation until specific tasks are completed.

First, additional discussion with the USEPA regarding background levels of CCB-derived COCs within the Area of Investigation is necessary. The Respondents can demonstrate that the inclusion of background samples in the HHRA evaluation that may contain up to 1% CCBs has virtually no impact on the comparison between potential risks associated with suspected CCBs and background soils. This evaluation then establishes that potential risks associated with suspected CCBs are within the range of background, thus meeting the RAO for the Area of Investigation. Nevertheless, the

Respondents will conduct additional background sampling and analysis, as proposed in Section 6.2.4.1.

Second, additional discussion with the USEPA regarding the representativeness of data from the Area of Investigation representing the RME scenario for completing the risk evaluation is necessary. Direct contact exposures to CCB-related COCs at the ground surface within the Area of Investigation were evaluated in the HHRA using USEPA guidance requiring the use of the 95% UCL on the arithmetic mean as the exposure point concentration, or EPC, for risk assessment purposes. This statistical treatment was used in the HHRA for the Pines Area of Investigation when assessing CCB-related COCs at the ground surface over an individual property. Therefore, although there may be some locations where an analytical result may be higher than the 95% UCL, that result is unlikely to represent the average concentration across a given property. As described in USEPA guidance, the reasonable maximum exposure (RME) scenario is not meant to define the absolute maximum of all exposure inputs, but rather reasonable upper bounds. As discussed in the USEPA-approved HHRA Report (Section 6.5.3.2), historical information indicates that the suspected CCBs present in residential lots are expected to be the same as CCBs encountered in rights-of-way (and sampled under the MWSE SAP). Thus the MWSE sample results provide a robust data set that is a reasonably conservative representation of suspected CCBs within the Area of Investigation. The Respondents have concluded from the existing information that the data collected from the MWSE installation are representative of the RME scenario for the ground surface, but USEPA views this as an uncertainty because it is possible that certain properties could contain higher concentrations of CCB-related constituents.

Before Soil Alternatives 3 and 4 can be quantitatively evaluated in the Feasibility Study, it is necessary to establish background concentrations of COCs in soils. Without this quantitative target, it will not be possible to design a meaningful remedy to meet the RAOs.

Therefore, as requested by USEPA, the Soil Alternatives have been presented separately, with the intention, as provided for by USEPA Comment #30, of addressing the GW Alternatives and Soil Alternatives on separate paths, before bringing them together in a final FS report.

6.2.3.1 Work Plan for Additional Analysis of Background Samples – Phase I

The HHRA showed that direct contact risks associated with CCBs in residential areas were similar to risks associated with background soils. However, some of the background soil samples were determined to contain trace amounts of CCBs. Because of this, USEPA is not prepared to rely on the current background dataset without additional evaluation. Specifically, additional background samples should be tested for the presence of CCBs, and if necessary, additional background samples may need to be collected. This updated/revised background evaluation is necessary to establish RAOs and identify alternatives to meet those objectives.

In response to USEPA comments on the RI Report, the Respondents submitted a subset of five of the 25 background soil samples for microscopic analysis to confirm the field visual observations regarding the absence of CCB materials in the samples. The results of these analyses were described in the HHRA, and were summarized in Section 2.2.2 of this document. Five of the background samples were analyzed for particulate matter to determine if CCBs are present in the samples. Three (3) of them were reported to contain trace levels of CCBs. One sample was reported to contain 1% bottom ash and a trace amount (<0.25%) fly ash, one sample was reported to contain 0.75% bottom ash and a trace amount (<0.25%) fly ash, and one sample was reported to contain <0.25% fly ash.

This background analysis was approved by the USEPA at the time (i.e., in its approval of the RI Report and the HHRA). Further, the Respondents have shown that the presence of these trace levels of CCBs has no effect on the conclusions of the HHRA. Nevertheless, the USEPA is now asking that soil samples used for the purpose of determining background levels of CCB-related constituents for the Area of Investigation be free of CCBs. The testing conducted to date has resulted in only two of the background samples meeting this criterion. Two samples are insufficient to conduct statistical analyses to calculate exposure point concentrations and representative background threshold concentrations.

The Respondents therefore will analyze additional background soil samples for CCB content, in order to obtain a data set that is robust for statistical analysis and calculating a background threshold value for CCB-related COCs (i.e., a minimum of 10 samples is needed).

Of the original 25 background soil samples, five have already been tested for CCBs. Of the remaining 20, sufficient sample volume remains for approximately 10 of these to be submitted for testing. Therefore, these 10 samples will be submitted to the RJ Lee Group for testing, following the same protocols as used for the previous testing.

Once the CCB analysis is completed, the number of background soil samples that are free of CCBs will be assessed, including both the two previously tested samples and the 10 additional samples. If the total number of samples meeting USEPA's criterion of being CCB-free is 10 or greater, and these samples include the representative soil types in the Area of Investigation (sand, clay, peat/organics), then these samples will be used as the revised background dataset. That is, the new background dataset would consist of a subset of samples (up to 12) from the original background dataset.

If the total number of background samples meeting USEPA's criterion of being CCB-free is less than 10, then additional background sample locations will need to be identified and sampled, in accordance with the background sampling and analysis procedures described in the Yard 520 Sampling and Analysis Plan (ENSR, 2005d). In this event, the Respondents would first provide a brief work plan to the USEPA for review and comment prior to conducting additional sampling. The work plan would include proposed sample locations. In addition, it is recommended that USEPA approve the sample locations in the field at the time of sample collection.

The available existing samples will be submitted for CCB testing as soon as written approval to continue is obtained from USEPA and a schedule has been agreed upon. The results will be provided to USEPA.

6.3 Summary of Remedial Alternatives

Remedial alternatives have been developed for groundwater and soil within the Pines Area of Investigation FS. These alternatives provide a range of options to address the RAOs established for the Area of Investigation. A detailed analysis of these alternatives will be conducted, which will include a detailed description and a comparison of each alternative to the nine CERCLA criteria; action-specific ARARs will be identified during the detailed analysis.

The alternatives carried forward to the detailed analysis are:

- Groundwater
    - GW Alternative 1: No Further Action
    - GW Alternative 2: Land Use Controls

  - GW Alternative 3: Monitored Natural Attenuation
  - GW Alternative 4: Active Groundwater Treatment
  - GW Alternative 5: Passive Groundwater Treatment
- Soil
  - Soil Alternative 1: No Further Action
  - Soil Alternative 2: Land Use Controls
  - Soil Alternative 3: CCB Removal
  - Soil Alternative 4: Capping

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Tables

TABLE 1
SUMMARY OF POTENTIAL HUMAN HEALTH RISKS – NON-DRINKING WATER PATHWAYS – RME SCENARIOS
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING TECHNICAL MEMORANDUM

AECOM

Background	Potential Carcinogenic Risks	Noncarcinogenic HQ (Target Endpoint and Constituent)	HHRA Table
Resident			
Chemical Constituents - Soils	Total: 1.85E-05 As: 1.85E-05	1.26 (Hair Tl)	6-7 RME 6-8RME
Radionuclides - Soils (Garden Scenario) & Brown Ditch Sediment	Total: 2E-05 Pb-210: 2.03E-06; Ra-226: 1.04E-05; Ra-228: 2.89E-06	(c)	6-34RME

Risk Pathway/Receptor	Site-Specific 27% CCB Scenario (d)				Hypothetical Screening-Level 100 % CCB Scenario (d)				HHRA Table
	Potential Carcinogenic Risks			Noncarcinogenic HQ (Target Endpoint and Constituent)	Potential Carcinogenic Risks			Noncarcinogenic HQ (Target Endpoint and Constituent)	
	$>10^{-4}$	$>10^{-5}$ but $<10^{-4}$	$>10^{-6}$ but $<10^{-5}$	HI>1	$>10^{-4}$	$>10^{-5}$ but $<10^{-4}$	$>10^{-6}$ but $<10^{-5}$	HI>1	
Chemical Constituents									
Resident									
Suspected CCBs & Brown Ditch (a)	None	Total: 1.78E-05 As: 1.70E-05	None	None	None	Total: 4.83E-05 As: 4.55E-05	Cr (VI): 2.79E-06	1.13 (GI Fe) 1.65 (Hair Tl)	6-1RME 6-2RME
Suspected CCBs & Pond 1 (a)	None	Total: 1.32E-05 As: 1.24E-05	None	None	None	Total: 4.38E-05 As: 3.91E-05	Cr(VI): 2.79E-06	1.08 (GI Fe) 1.65 (Hair Tl)	6-3RME 6-4RME
Suspected CCBs & Pond 2 (a)	None	Total: 1.83E-05 As: 1.76E-05	None	None	None	Total: 4.89E-05 As: 4.61E-05	Cr(VI): 2.79E-06	1.18 (GI Fe) 1.65 (Hair Tl)	6-5RME 6-6RME
Recreational Child									
Suspected CCBs & Brown Ditch (a)	NA	NA	NA	NA	None	None	Total: 3.38E-06 As: 3.38E-06	None	6-9RME 6-10RME
Suspected CCBs & Pond 1 (a)	NA	NA	NA	NA	None	None	Total: 1.09E-06 As: 1.09E-06	None	6-11RME 6-12RME
Suspected CCBs & Pond 2 (a)	NA	NA	NA	NA	None	None	Total: 4.01E-06 As: 4.01E-06	None	6-13RME 6-14RME
Recreational Fisher									
Suspected CCBs & Brown Ditch (a)	NA	NA	NA	NA	None	None	Total: 3.07E-06 As: 3.07E-06	None	6-15RME 6-16RME
Suspected CCBs & Pond 1 (a)	NA	NA	NA	NA	None	None	None	None	6-17RME 6-18RME
Suspected CCBs & Pond 2 (a)	NA	NA	NA	NA	None	None	Total 2.99E-06 As: 2.99E-06	None	6-19RME 6-20RME
Construction Worker									
Suspected CCBs and Groundwater (b)	NA	NA	NA	NA	None	None	None	None	6-23RME 6-24RME

TABLE 1
SUMMARY OF POTENTIAL HUMAN HEALTH RISKS – NON-DRINKING WATER PATHWAYS – RME SCENARIOS
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING TECHNICAL MEMORANDUM

AECOM

Risk Pathway/Receptor	Site-Specific 27% CCB Scenario (d)				Hypothetical Screening-Level 100 % CCB Scenario (d)				HHRA Table
	Potential Carcinogenic Risks			Noncarcinogenic HQ (Target Endpoint and Constituent)	Potential Carcinogenic Risks			Noncarcinogenic HQ (Target Endpoint and Constituent)	
	$>10^{-4}$	$>10^{-5}$ but $<10^{-4}$	$>10^{-6}$ but $<10^{-5}$	HI>1	$>10^{-4}$	$>10^{-5}$ but $<10^{-4}$	$>10^{-6}$ but $<10^{-5}$	HI>1	
Outdoor Worker									
Suspected CCBs	None	None	Total 3.35E-06 As 3.35E-06	None	None	Total: 1.24E-05 As: 1.24E-05	None	None	6-25RME 6-26RME
Radionuclides									
Resident									
Suspected CCBs (Garden Scenario) & Brown Ditch Sediment	None	Total: 4E-05 Ra-226: 2E-05 (e)	Pb-210: 9E-06 Ra-228: 8E-06 (e)	(c)	Total: 2E-04	Pb-210: 3E-05 Ra-226: 9E-05 Ra-228: 3E-05	U-238: 2E-06	(c)	6-33RME
Outdoor Worker									
Suspected CCBs	None	Total: 3E-05 Ra-226: 3E-05 (e)	Ra-228: 4E-06 (e)	(c)	Total: 1E-04	Ra-226: 9E-05 Ra-228: 1E-05	Pb-210: 2E-06 U-238: 1E-06	(c)	6-33RME
Construction Worker									
Suspected CCBs	None	None	NA	(c)	None	None	Total: 1E-06	(c)	6-33RME
Recreational Fisher									
Suspected CCBs and Brown Ditch Sediment	None	None	NA	(c)	None	None	Total: 1.22E-06	(c)	6-33RME
Recreational Child									
Suspected CCBs and Brown Ditch Sediment	None	None	None	(c)	None	None	None	(c)	6-33RME

Risk Pathway/Receptor	Site-Specific 27% CCB Scenario (d)				Hypothetical Screening-Level 100 % CCB Scenario (d)				HHRA Table
	Potential Carcinogenic Risks			Noncarcinogenic HQ (Target Endpoint and Constituent)	Potential Carcinogenic Risks			Noncarcinogenic HQ (Target Endpoint and Constituent)	
	$>10^{-4}$	$>10^{-5}$ but $<10^{-4}$	$>10^{-6}$ but $<10^{-5}$	HI>1	$>10^{-4}$	$>10^{-5}$ but $<10^{-4}$	$>10^{-6}$ but $<10^{-5}$	HI>1	

Notes:
Blue text indicates a total potential risk value above background.
(a) Scenario includes potential exposure to surface water and sediment in the identified water body.
(b) Scenario includes potential exposure to groundwater via incidental ingestion and dermal contact.
(c) Noncarcinogenic hazards are not calculated for radionuclides.
(d) The risk and hazard estimates are based on the 95% UCL, calculated using USEPA's ProUCL software. The statistical calculation of the 95% UCL takes into account the variability in the data. However, it is possible that there may be location(s) on individual properties may contain CCB-related COPC concentrations associated with potential risks greater than or equal to the risk range of 10^{-6} to 10^{-4} and/or hazards greater than 1. Note that it is the concentration across an exposure area, not individual locations that are relevant to risk assessment. The 27%CCB scenario is applicable only to residential and outdoor worker potential exposures to CCBs. Construction workers were assumed to contact 100% CCBs, and recreational receptors were assumed to breathe dusts containing 100% CCBs. Surface water, sediment, and fish tissue exposures for both recreational and residential receptors are unrelated to the %CCB exposure scenarios. Therefore, construction worker and recreational receptor potential risks and hazards are presented under the 100% CCB scenario. Potential risks and hazards for residential and outdoor worker receptors are presented under both scenarios. However, it should be noted that since potential risks and hazards for the residential receptor for surface water, sediment, and fish tissue are unrelated to the %CCB exposure scenario, they are the same under both the 27% and the 100% scenarios.
(e) USEPA guidance identifies a standard of 5 pCi/g above background that is used to assess the combined levels of radium-226 and radium-228. Background soil data collected during the Remedial Investigation were used to statistically derive a background threshold value for the sum of the radiums, which ranges from 1 to 2 pCi/g; therefore, the resulting 5 pCi/g plus background range is 6 to 7 pCi/g. As shown in Appendix J of the HHRA report, all of the results from the MWSE suspected CCB dataset, the Brown Ditch sediment dataset and the Upgradient sediment dataset are below this 5 pCi/g plus background range.

Acronyms and Abbreviations:
As - Arsenic.
CCBs - Coal Combustion By-products.
COPC - Constituent of Potential Concern
Cr (VI) - Hexavalent Chromium.
Fe - Iron.
GI - Gastrointestinal.
HHRA - Human Health Risk Assessment.
HI - Hazard Index.
HQ - Hazard Quotient
MWSE - Municipal Water Service Extension.
NA - Not Applicable – Site-specific 27% CCB scenario does not apply to this receptor.
Pb - Lead.
pCi/g - PicoCuries per gram.
Ra- Radium.
RME - Reasonable Maximum Exposure.
Tl - Thallium.
U - Uranium.
UCL - Upper Confidence Limit.
USEPA - United States Environmental Protection Agency.

TABLE 2
SUMMARY OF POTENTIAL GROUNDWATER RISKS (d)
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING TECHNICAL MEMORANDUM

Exposure Pathway/Area	Potential Carcinogenic Risks			Non-Carcinogenic Hazards	MCL Exceedances (see HHRA Table 3-27)	HHRA Table Reference for Risks
	$>10^{-4}$	$>10^{-5}$ but $<10^{-4}$	$>10^{-6}$ but $<10^{-5}$	HI>1		
Construction Worker Pathway – Monitoring Wells						
Groundwater	None	None	None	None	--	6-21RME 6-22RME
Drinking Water Pathway – Background Wells						
Groundwater	None	MW120: As	None	None	None	6-46 to 6-49 6-81 (summary)
Drinking Water Pathway – Private Wells						
Groundwater	None	None	None	None	None	6-37 to 6-45 6-81 (summary)
Drinking Water Pathway – Monitoring Wells						
Groundwater – Yard 520 wells (i.e., located on Yard 520 property)	MW6: As MW8: As	None	None	MW3: B MW6: As,B MW8: B MW10: B TW12: B	MW6: As MW8: As	6-56 to 6-78 6-81 (summary)
Groundwater – served by MWSE (c) (excluding Yard 520)	TW15D: As	MW104: As (b)	None	TW15D: As TW16D: Mn TW18D: Mn	TW15D:As MW106: Se	6-56 to 6-78 6-81 (summary)
Groundwater – outside MWSE (a)	MW111: As MW122: As	None	None	MW111: Fe, Mn, Tl MW122:As,B	MW111: As MW122: As	6-50 to 6-55 6-81 (summary)

Notes:

(a) Only two wells located in the area not served by the MWSE showed potential risks above benchmarks in the drinking water pathway evaluation. While MW111 and MW122 are impacted by CCBs, they are located in wetland areas that are unlikely to be developed. Therefore, the drinking water pathway is not likely to be complete for these wells.
(b) MW104 is located within the MWSE along West Dunes Highway. Concentrations of As are below the MCL, and other indicator parameters show this well appears to be impacted by septic systems and not CCB-derived constituents (see Section 4.4.4 of the RI Report).
(c) Within the area served by the MWSE, there are certain property owners who elected not to connect to the MWSE.
(d) Groundwater data used in the HHRA is representative of the time period over which it was collected. Review of the groundwater elevation contours and the constituent data over the course of the RI indicates that the constituent distribution in groundwater is largely controlled by the groundwater hydraulic gradients (direction of groundwater flow) and location relative to Brown Ditch, and groundwater flow is not expected to change significantly in the future in the absence of major unforeseen changes. Therefore, while the there is no information that would suggest that these conditions would change dramatically in the future, this remains a source of uncertainty in the risk assessment.

Acronyms and Abbreviations:

As - Arsenic.
B - Boron.
CCB - Coal Combustion By-products.
Fe - Iron.
HHRA - Human Health Risk Assessment.
HI - Hazard Index.
MCL - Maximum Contaminant Level.
Mn - Manganese.
MWSE - Municipal Water Service Extension.
RI - Remedial Investigation.
RME – Reasonable Maximum Exposure.
Se - Selenium.
Tl – Thallium.

TABLE 3
SUMMARY OF STEP 3A OF THE ERA
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING TECHNICAL MEMORANDUM

AECOM

	Brown Ditch Exposure Area												
	Benthic Community		Aquatic Community (c)		Brown Ditch Aquatic Food Web (d)							Root Zone Exposure	
COPECs	**Sediment (a)**	**Groundwater (b)**	**Surface Water-Dissolved**	**Surface Water-Total Recoverable**	**Belted Kingfisher**	**Mink**	**Raccoon**	**Green Heron**	**Little Brown Bat**	**Mallard**	**Muskrat**	**Sediment (e)**	**Groundwater (f)**
ALUMINUM											**3.0**		
ARSENIC													
BARIUM													
BORON												**156**	see Table 5-18 of SERA for sample by sample execcedances
CHROMIUM												**14.4**	
CHROMIUM (HEXAVALENT)													
COBALT													
COPPER													
IRON		see Table 5-15 of SERA for sample by sample execcedances		**3.0**								**1.6**	see Table 5-18 of SERA for sample by sample execcedances
LEAD													
MANGANESE												**1.4**	
MERCURY													
MOLYBDENUM												**5.6**	
NICKEL													
SELENIUM					**1.0**							**6.9**	
STRONTIUM													
THALLIUM													
URANIUM-TOTAL													
VANADIUM												**14.7**	
ZINC													

Notes:
(a) Sediment HQs for benthic receptors - average HQ with refined ESV is presented.
(b) Sample by sample groundwater evaluation for benthic community receptors presented in Table 5-15 of the SERA Report.
(c) Surface water HQs - average HQ with refined ESV is presented.
(d) Food web HQs - LOAEL-based HQ for the average EPC is presented.
(e) Sediment HQs for root zone exposure - average HQ presented.
(f) Sample by sample groundwater evaluation for root zone exposure presented in Table 5-18 of the SERA Report.
(g) Suspected CCB HQs for terrestrial plant and invertebrate community receptors - average HQs presented.

Acronyms and Abbreviations:
CCB - Coal Combustion By-Product.
COPEC - Constituent of Potential Ecological Concern.
EPC - Exposure Point Concentration.
ERA - Ecological Risk Assessment.
ESV - Ecological Screening Value.
HQ - Hazard Quotient HQs greater than 1 are presented.
LOAEL - Lowest Observed Adverse Effect Level.
NV - No Value Ecological screening could not be conducted due to a lack of screening value.
SERA - Screening Level Ecological Risk Assessment.
TRV - Toxicity Reference Value.

	Pond Exposure Area									
	Benthic Community	Aquatic Community (c)		Pond Exposure Area Aquatic Food Web (d)						
COPECs	Sediment (a)	Surface Water - Dissolved	Surface Water - Total Recoverable	Belted Kingfisher	Mink	Raccoon	Green Heron	Little Brown Bat	Mallard	Muskrat
ALUMINUM					1.1					8.7
ARSENIC										
BARIUM										
BORON										
CHROMIUM										
CHROMIUM (HEXAVALENT)										
COBALT										
COPPER										
IRON	1.1	4.4	1.7							
LEAD										
MANGANESE										
MERCURY										
MOLYBDENUM										
NICKEL										
SELENIUM	1.3									1.5
STRONTIUM										
THALLIUM										
URANIUM-TOTAL										
VANADIUM										
ZINC										

Notes:
(a) Sediment HQs for benthic receptors - average HQ with refined ESV is presented.
(b) Sample by sample groundwater evaluation for benthic community receptors presented in Table 5-15 of the SERA Report.
(c) Surface water HQs - average HQ with refined ESV is presented.
(d) Food web HQs - LOAEL-based HQ for the average EPC is presented.
(e) Sediment HQs for root zone exposure - average HQ presented.
(f) Sample by sample groundwater evaluation for root zone exposure presented in Table 5-18 of the SERA Report.
(g) Suspected CCB HQs for terrestrial plant and invertebrate community receptors - average HQs presented.

Acronyms and Abbreviations:
CCB - Coal Combustion By-Product.
COPEC - Constituent of Potential Ecological Concern.
EPC - Exposure Point Concentration.
ERA - Ecological Risk Assessment.
ESV - Ecological Screening Value.
HQ - Hazard Quotient HQs greater than 1 are presented.
LOAEL - Lowest Observed Adverse Effect Level.
NV - No Value Ecological screening could not be conducted due to a lack of screening value.
SERA - Screening Level Ecological Risk Assessment.
TRV - Toxicity Reference Value.

AECOM

	Terrestrial Exposure Area												
	Terrestrial Plant Community (g)	Terrestrial Invertebrate Community (g)	Terrestrial Food Web (d)								Grit Ingestion Evaluation (d)		
COPECs	Suspected CCBs	Suspected CCBs	Red-Tailed Hawk	Red Fox	Raccoon	Eastern Meadowlark	American Robin	Least Shrew	Canada Goose	Meadow Vole	Eastern Meadowlark	American Robin	Canada Goose
ALUMINUM													
ARSENIC	**1.3**												
BARIUM													
BORON	**166**	**4.2**											
CHROMIUM	**85.2**	**213**											
CHROMIUM (HEXAVALENT)		**2.3**											
COBALT													
COPPER													
IRON		**364**											
LEAD													
MANGANESE													
MERCURY													
MOLYBDENUM	**2.2**												
NICKEL								**1.5**					
SELENIUM	**1.8**												
STRONTIUM													
THALLIUM	**1.4**							**3.5**					
URANIUM-TOTAL													
VANADIUM	**30.4**	**3.0**				**1.4**	**2.0**				**1.8**	**2.3**	
ZINC													

Notes:
(a) Sediment HQs for benthic receptors - average HQ with refined ESV is presented.
(b) Sample by sample groundwater evaluation for benthic community receptors presented in Table 5-15 of the SERA Report.
(c) Surface water HQs - average HQ with refined ESV is presented.
(d) Food web HQs - LOAEL-based HQ for the average EPC is presented.
(e) Sediment HQs for root zone exposure - average HQ presented.
(f) Sample by sample groundwater evaluation for root zone exposure presented in Table 5-18 of the SERA Report.
(g) Suspected CCB HQs for terrestrial plant and invertebrate community receptors - average HQs presented.

Acronyms and Abbreviations:
CCB - Coal Combustion By-Product.
COPEC - Constituent of Potential Ecological Concern.
EPC - Exposure Point Concentration.
ERA - Ecological Risk Assessment.
ESV - Ecological Screening Value.
HQ - Hazard Quotient HQs greater than 1 are presented.
LOAEL - Lowest Observed Adverse Effect Level.
NV - No Value Ecological screening could not be conducted due to a lack of screening value.
SERA - Screening Level Ecological Risk Assessment.
TRV - Toxicity Reference Value.

TABLE 4
SUMMARY OF CHEMICAL-SPECIFIC ARARS
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING MEMORANDUM

Media	Requirement	Requirement Synopsis	Action to be Taken to Attain Requirement	Status
Surface Water	Surface Water Quality Standards 327 IAC 2-1.5	The State of Indiana has promulgated SWQS for surface waters within the Great Lakes System (327 IAC 2-1.5) and waters not within the Great Lakes System (327 IAC 2-1). Surface waters within the Pines Area of Investigation are within the Great Lakes System, thus 327 IAC 2-1.5 apply.	The State regulations state that the chemical, physical, and biological integrity of the waters within the Great Lakes system shall be maintained or restored; thus, the discharge of toxic substances in toxic certain amounts is prohibited, and persistent and bioaccumulating toxic substances shall be reduced or eliminated (these are further discussed below). Further, for all surface waters of the Great Lakes system, existing instream water uses and the level of water quality necessary to protect existing uses shall be maintained and protected. Because the State of Indiana has promulgated surface water standards, they replace the federal WQC as ARARs for surface water in the Pines Area of Investigation.	Applicable
Groundwater	Groundwater Quality Standards 327 IAC 2-11	These regulations provide groundwater protection to wells and allow for the classification of groundwater. The rule states that all groundwater of the state shall be classified as “drinking water class” groundwater unless it is classified as “limited class” groundwater or “impaired drinking water class” groundwater. The regulations also provide qualitative and quantitative groundwater quality standards for compounds of concern.	Groundwater in the Pines Area of Investigation has not been classified as “limited class” or “impaired drinking water class”; so is considered a drinking water class groundwater. Thus, for the Pines Area of Investigation, the Indiana GQS are applicable to water wells in the Area of Investigation.	Applicable
Groundwater	Safe Drinking Water Act MCLs 40 CFR Part 141 Subpart B (141.11 – 141.13)	MCLs are enforceable standards that regulate the concentration of specific organic and inorganic contaminants that have been determined to adversely affect human health in public drinking water supplies. They may be considered relevant and appropriate for groundwater aquifers potentially used for drinking water.	MCLs are only applicable where groundwater undergoing a CERCLA cleanup is delivered through a public water supply system, if that system has at least 15 service connections or serves at least 25 year-round residents. Groundwater in the Area of Investigation is tapped by some households for potable use (other households have access to a municipal water supply). However, groundwater is typically tapped for potable use on an individual basis, and, no well serves more than 25 year-round residents. Thus the federal MCLs are not applicable. MCLs are potentially relevant and appropriate for groundwater this is a current or potential source of drinking water (USEPA, 1991a). Groundwater in the Pines Area of Investigation is considered by the State of Indiana a drinking water class groundwater; thus, the federal MCLs are relevant and appropriate. The only COPCs in groundwater in the Pines Area of Investigation where concentrations exceed MCLs are arsenic and selenium.	Relevant and Appropriate
Groundwater	Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings 40 CFR §192.12	This statute was established to protect human health and the environment from mining and milling activities associated with the nation’s nuclear program at 24 sites that were identified by name in the statute.	While these regulations are only applicable to the control of residual radioactive material at designated processing or depository sites under Section 108 of UMTRCA, USEPA has suggested (and provided guidance) where these criteria should be considered relevant and appropriate at other CERCLA sites. These regulations identify soil levels for radium-226 and thorium by-product material pursuant to Section 84 of Atomic Energy Act (5 pCi/g on the surface [upper 15 cm]). http://www.epa.gov/superfund/health/contaminants/radiation/pdfs/umtrcagu.pdf	Relevant and Appropriate

TABLE 4
SUMMARY OF CHEMICAL-SPECIFIC ARARS
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING MEMORANDUM

Media	Requirement	Requirement Synopsis	Action to be Taken to Attain Requirement	Status
Groundwater	USEPA RSL for Chemical Constituents at Superfund Sites, May 2012	RSLs are developed by the USEPA using risk assessment guidance from the USEPA Superfund program. They are risk-based concentrations derived from standardized equations combining exposure information assumptions with USEPA toxicity data. RSLs are generic; they are calculated without site-specific information. They may be re-calculated using site-specific data.	An RSL is typically used for initial site "screening". An RSL is not a de facto cleanup standard and should not be applied as such. The role of an RSL in site "screening" is to help identify areas, constituents, and conditions that require further attention at a particular site. Generally, where a constituent concentration falls below an RSL, no further action or study is warranted under the Superfund program. A constituent concentration above an RSL would not automatically call for a response action. RSLs have been included as a TBC criterion for the Pines Area of Investigation, in the consideration of establishing RAOs.	To Be Considered
Soil	IDEM, RISC Remediation Closure Guide, March 2012	The RISC program was developed to promote consistency in the closure of impacted soil and groundwater areas in the State of Indiana. The Remediation Closure Guide is a non-rule policy document intended to clarify for the public IDEM's interpretation of relevant environmental statutes and rules. It does not have the effect of law. The Remediation Closure Guide became effective on March 22, 2012. It is a revision of the 2001 RISC Technical Resource Guidance Document.	The RISC Remediation Closure Guide is a non-rule policy document, which means that it does not have the force and effect of law and is not an ARAR for the Pines Area of Investigation. It is classified only as a TBC criterion. The Closure Guide provides soil direct contact screening levels for several exposure scenarios. As stated in the Guide, “A comparison….of [exposure point concentrations]…derived from site analytical data against appropriate screening levels is usually the first step when evaluating potential exposure risk. Appropriate screening levels depend on the likely exposure scenario.”	To Be Considered

Acronyms and Abbreviations:

ARAR – Applicable or Relevant and Appropriate Requirements.

CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act.

CFR – Code of Federal Regulations.

cm – centimeters.

COPC – Constituent of Potential Concern.

GQS – Groundwater Quality Criteria.

IAC – Indiana Administrative Code.

IDEM – Indiana Department of Environmental Management.

MCL – Maximum Contaminant Level.

pCi/g – PicoCuries per gram.

RISC – Risk Integrated System of Closure.

RSL – Regional Screening Level.

SWQS – Surface Water Quality Standard.

TBC – To Be Considered.

UMTRCA - Uranium Mill Tailings Radiation Control Act.

USEPA – United States Environmental Protection Agency.

WQC – Water Quality Criteria.

TABLE 5
SUMMARY OF LOCATION-SPECIFIC ARARS
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING MEMORANDUM

Media	Requirement	Requirement Synopsis	Action to be Taken to Attain Requirement	Status
Wetlands	Fish and Wildlife Coordination Act Regulations 33 CFR Part 320.3 (16 USC 661 et seq.)	Requires that the U.S. Fish and Wildlife Services and National Marine Fisheries Service be consulted prior to structural modification of any stream or other water body (e.g., wetland). It also requires adequate protection of fish and wildlife resources, and consultation with state agencies to develop measures to prevent, mitigate, or compensate for project-related losses to fish and wildlife.	If wetlands within the Area of Investigation are subject to investigation or remediation activities, then these regulations may come into play a proposed action would have to show that “no practicable alternative exists” to the work being proposed, and that construction activities will be conducted in such a manner to mitigate impacts to fish and wildlife resources. Relevant federal and state agencies must be provided with the engineering design and/or work plan for the proposed action for review prior to implementation of the work.	Relevant and Appropriate
Wetlands	Clean Water Act Guidelines for Specification of Disposal Sites for Dredged or Fill Material CWA Section 404(b)(1) 40 CFR Part 230	These guidelines apply to all existing, proposed, or potential disposal sites for discharges of dredged or fill material into U.S. waters (including wetlands). A discharge is not allowed if there is a practicable alternative that would have a less adverse impact on the aquatic ecosystem. Also, a discharge is not allowed unless appropriate and practicable steps are taken to minimize potential adverse impacts on the aquatic ecosystem. These guidelines must be met before a CWA Section 404 permit can be issued. These guidelines also include specifications for compensatory mitigation.	If a remedial action for the Area of Investigation requires the discharge of dredged or fill material into a wetland, and there is no practicable alternative that would have a less adverse impact on the aquatic ecosystem, the remedial action would have to minimize potential adverse impacts to the aquatic ecosystem and any adverse impacts would have to be mitigated.	Applicable to actions that may involve the discharge of dredged materials to a wetland
Wetlands	CWA Section 401 Water Quality Certification	These regulations provide for the state Water Quality Certification as per Section 401 of the CWA. These regulations cover dredging, filling, excavation and placement of structures in all wetlands, tidal waters, and navigable freshwaters.	If wetlands within the Area of Investigation are subject to investigation or remediation activities, and CWA Section 404 applies, then a Section 401 WQC must be obtained from IDEM.	Applicable
Water	CWA Section 404	These regulations provide the Federal wetlands and navigable waters regulatory program, which is administered by the USACE. It covers dredging, filling, excavation and placement of structures in all wetlands, tidal waters, and navigable freshwaters. Issuance of these permits requires compliance with Section 401 WQC (of which the IDEM has been given the authority to implement), and compliance with the Federal Endangered Species Act and Section 106 of the National Historic Preservation Act (Historic and Archaeological Features).	If wetlands within the Area of Investigation are subject to investigation or remediation activities, then these regulations would come into play. The investigation or remedial actions would be considered “on-site” as per the CERCLA On-Site Policy, and so only substantive requirements must be complied with to the maximum extent practicable. A proposed action must show that “no practicable alternative exists” to the work being proposed, and that any construction activities will be conducted in such a manner to mitigate impacts and minimize harm to the wetlands.	Relevant and Appropriate

TABLE 5
SUMMARY OF LOCATION-SPECIFIC ARARS
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING MEMORANDUM

Media	Requirement	Requirement Synopsis	Action to be Taken to Attain Requirement	Status
Floodplains	Flood Control Act and Flood Plain Management Rule 312 IAC 10	These requirements regulate certain activities within the floodway produced by the regulatory flood. The “regulatory flood” is equivalent to the base flood or the 100-year frequency flood. “Floodway” means “the channel of a river or stream and those portions of the flood plains adjoining the channel that are reasonably required to efficiently carry and discharge the peak flow of the regulatory flood of any river or stream.” These regulations are intended to control and minimize the extent, height, and force of potential floods. Regulated activities include vegetation clearing in buffers, and the placement of structures within the floodway, flood fringe, or flood plain.	Projects or portions of projects are not subject to Indiana regulation if a waterway’s drainage area at the downstream end of the project site is less than 1 square mile (640 acres), or if the total length of the stream or drain is less than or equal to 10 miles. If these regulations apply, impacts against the following criteria should be reviewed: 1) whether or not the project will adversely affect the efficiency of, or unduly restrict the capacity of, the floodway; 2) whether or not the project will constitute an unreasonable hazard to the safety of life or property; and 3) whether or not the project will result in unreasonably detrimental effects upon fish, wildlife, or botanical resources.	Potentially applicable
Floodplains	Indiana Drainage Code IC 36-9-27 Section 53.5	Section 53.5 states that if a reconstruction or maintenance project is subject to regulation under the Indiana Flood Control Act, or if it requires a permit under Section 404 of the federal CWA, the county surveyor or drainage board shall request an on-site field review of the project. The on-site field review is conducted by one or more staff representatives from the county, the IDNR, including one engineer each from the Division of Water, IDEM, and the local Soil and Water Conservation District, if applicable.	If floodplains within the Area of Investigation are subject to investigation or remediation activities, then these regulations may come into play.	Potentially applicable
Endangered Species	Endangered Species Act 50 CFR 17	These regulations provide for the conservation of threatened and endangered plants and animals and the habitats in which they are found. The U.S. Fish and Wildlife Service maintains the list of endangered and threatened species. These regulations prohibit any action, administrative or real, that results in a "taking" of a listed species, or adversely affects habitat.	If endangered or threatened species are present within areas that may be subject to investigation or remediation activities, then these regulations may come into play. Precautions to prevent impacts to identified habitats would be imposed during investigation or remediation activities.	Applicable
Endangered Species	Non-Game and Endangered Species Conservation IC 14-22-34	These regulations provide for the conservation of threatened and endangered plants and animals and the habitats in which they are found. These regulations prohibit any action, administrative or real, that results in a "taking" of a listed species, or adversely affects habitat.	If endangered or threatened species are present within areas that may be subject to investigation or remediation activities, then these regulations may come into play. Precautions to prevent impacts to identified habitats would be imposed during investigation or remediation activities.	Potentially Applicable
Land Disposal Requirements	Land Disposal Facilities 329 IAC 10	These regulations govern the siting, operation, closure and post-closure activities at land disposal facilities in Indiana.	Closure requirements for Type II and Type III Restricted Waste Site include a closure plan, approved by IDEM and incorporated into the landfill’s operating permit, cover/capping and grading. Post-closure maintenance, monitoring and reporting is required for at least 30 years after IDEM approves the final closure. The post-closure plan, approved by IDEM and incorporated into the operating permit, must include these topics.	Applicable

TABLE 5
SUMMARY OF LOCATION-SPECIFIC ARARS
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING MEMORANDUM

Media	Requirement	Requirement Synopsis	Action to be Taken to Attain Requirement	Status

Acronyms and Abbreviations:

ARAR – Applicable or Relevant and Appropriate Requirements.

CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act.

CFR – Code of Federal Regulations.

CWA – Clean Water Act.

IAC – Indiana Administrative Code.

IC – Indiana Code.

IDEM – Indiana Department of Environmental Management.

IDNR – Indiana Department of Natural Resources.

USACE – United States Army Corps of Engineers.

USC – United States Code.

WQC – Water Quality Certification.

TABLE 6
IDENTIFICATION OF POTENTIAL REMEDIAL TECHNOLOGIES
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING MEMORANDUM

General Response Action	Basic Operating Principle	Example Technologies	General Description
No Action	None	▪ None	No action would be taken.
No Further Action	Prior actions	▪ Remedial actions taken prior to or concurrent with the RI/FS ▪ Actions taken in response to applicable regulatory programs	For the Pines Area of Investigation, the MWSE was a response action that was taken prior to and concurrent with the RI. Also, Yard 520 has been closed in accordance with applicable IDEM regulations, and is being maintained in accordance with the approved Post-Closure Plan.
Land Use Controls	Institutional Controls	▪ Deed Restrictions ▪ Groundwater Ordinance ▪ Alternate Controls/Measures	Institutional controls place restrictions on use of a property or properties on a site (e.g., use of groundwater for drinking, zoning restrictions, subsurface work requirements). These methods can be legal mechanisms (e.g., deed restrictions or groundwater ordinances), or other methods that would similarly limit the use of a property to address a Remedial Action Objective. Alternate institutional controls could be implemented to support groundwater use restrictions or other activities. These may consist of: a periodic well survey to ensure that no new wells have been installed; and/or periodic review with the Town and/or County to review if any well installation permits have been issued for the area.
	Physical Controls	▪ Alternate Water Supply	An alternative water supply prevents exposure to constituents in groundwater via drinking. The installation of the MWSE for a large portion of the Area of Investigation was completed in 2006. The MWSE has been in place since 2006 and is a primary remedial action for the Pines Area of Investigation. See Figure 3 for location of the MWSE Area.
Containment	Cap	▪ Engineered Cap; Soil cover; other surficial covers	A barrier is placed over an impacted area to prevent 1) human and ecological receptor exposure with underlying soils and/or 2) the infiltration of rainwater or runoff to prevent the mobilization of subsurface constituents. Note that Yard 520 was closed in accordance with applicable IDEM regulations, including installation of a cap, and is being maintained in accordance with the approved Post-Closure Plan.
	Passive	▪ Physical (Vertical) Barrier ▪ Slurry Wall	A physical barrier, such as sheet piling, concrete or slurry wall, is constructed across the path of groundwater flow. The barrier is an impermeable wall and provides sustained isolation of constituents and prevents downgradient migration of groundwater over long periods of time. In most cases, the excavation is extended into a low permeability stratum such as clay or bedrock to assure minimal pass-through of constituents under the wall.

TABLE 6
IDENTIFICATION OF POTENTIAL REMEDIAL TECHNOLOGIES
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING MEMORANDUM

General Response Action	Basic Operating Principle	Example Technologies	General Description
	Active	▪ Hydraulic Barrier -- Groundwater Extraction ▪ Permeable Reactive Barrier ▪ Phytoremediation	A hydraulic barrier is primarily used to contain dissolved constituents within a limited area, and/or to manage migration of dissolved constituents. Extraction is accomplished through a series of wells, trenches, drains or ditches placed perpendicular to the flow of groundwater. Groundwater extraction is most effective in the recovery of constituents that are readily soluble in groundwater and where the impacted portion of the saturated zone of soils is relatively permeable (e.g., sands and gravels). Groundwater is typically treated before discharge. The PRB technology typically includes a permeable wall/barrier installed across the flow path of affected groundwater, allowing the plume to flow through the wall under natural gradients. Groundwater is treated passively by employing agents within the wall such as zero-valent metals, chelators, sorbents, and microbes, thus intercepting downgradient migration of constituents.
Ex Situ Removal / Treatment	Groundwater Extraction and Treatment	▪ Groundwater Extraction and Treatment	Groundwater treatment is used in combination with the groundwater extraction technology identified above (see hydraulic barrier). Extracted groundwater is treated either on site (e.g., ion exchange, metal hydride precipitation or reverse osmosis) or at an off-site facility (i.e., wastewater treatment works). In most cases, discharge of extracted groundwater is a logistical challenge.
	CCB Removal	▪ Excavation, on-site treatment ▪ Excavation, off-site treatment and disposal	Excavation from impacted areas and off-site disposal of the excavated material is a physical process that would permanently remove the constituents in soil. Off-site treatment involves transport and disposal of excavated materials to an appropriate facility. On-site treatment of excavated material may require permitting for the siting and operation of the treatment facility.
In Situ Treatment	Monitored Natural Attenuation	▪ Monitored Natural Attenuation	Monitored Natural Attenuation refers to natural processes that reduce the mass, toxicity, mobility, volume, or concentration of constituents. A monitoring program monitors key parameters of the groundwater to document the naturally-occurring degradation processes and concentrations over time. These processes include advective transport, dispersion, retardation/soil partitioning, degradation and chemical reactions and oxidation/reduction (redox) effects. These processes influence a constituent's fate and transport. These natural mechanisms can reduce the concentration, rate of transport, and total mass of the constituents.
	Other treatment (e.g., via aeration, thermal, etc., methods)	▪ Air Sparging/Soil Vapor Extraction/bioventing ▪ Electrical Heating ▪ Steam Injection	*In situ* treatment technologies are chemical, physical, biological, thermal or electrical processes that remove, degrade, chemically modify, stabilize or encapsulate constituents of concern within soil or groundwater (matrices) without removing those matrices from the ground.

TABLE 6
IDENTIFICATION OF POTENTIAL REMEDIAL TECHNOLOGIES
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING MEMORANDUM

General Response Action	Basic Operating Principle	Example Technologies	General Description

Acronyms and Abbreviations:

CERCLA - Comprehensive Environmental Response, Compensation and Liability Act.

IDEM - Indiana Department of Environmental Management.

MWSE - Municipal Water Service Extension.

PRB - Permeable Reactive Barrier.

RI/FS - Remedial Investigation/Feasibility Study.

TABLE 7
SCREENING OF POTENTIAL REMEDIAL TECHNOLOGIES
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING MEMORANDUM

AECOM

Basic Operating Principle / Alternative	Example Technologies	Effectiveness	Implementability	Screening Status
No Action (Soil / Groundwater)	▪ Not applicable	▪ Not applicable	▪ The no-action alternative is not applicable to the Pines Area of Investigation because Remedial Actions have already been completed.	**Eliminated**
No Further Action (Soil / Groundwater)	▪ Remedial actions taken prior to or concurrent with the RI/FS ▪ Actions taken under applicable regulatory programs	▪ The MWSE was a response action taken prior to and concurrent with the RI. ▪ Yard 520 was closed in accordance with applicable IDEM regulations, and is being maintained in accordance with the approved post-closure plan. ▪ The no further action option achieves some but not all of the RAOs established for the Area of Investigation.	▪ There are no implementation obstacles to the No Further Action option. ▪ Note that this work was completed in 2003/2004, well before the conclusion of the RI/FS for the project.	**Retained** ▪ The no further action option is retained to provide a baseline for comparison with other options.
Land Use Controls (Soil / Groundwater)	▪ Institutional Controls (e.g., local groundwater ordinance, deed restrictions) ▪ Alternate Institutional Controls (e.g., notifications, monitoring plans) ▪ Physical Controls (e.g., additional alternate water source)	▪ A physical control has been implemented in the Area of Investigation. The provision of a municipal water service (via the MWSE) to a large portion of the Area of Investigation has been highly effective in reducing exposure to CCB-derived COCs in drinking water. ▪ Groundwater within residential areas outside the current MWSE area meets RAOs, thus further extension of the MWSE is not necessary. ▪ A groundwater ordinance is a local law put into place to prevent specific uses of groundwater in a certain area (i.e., over a portion of the local municipality). Such an ordinance could be implemented on properties within the MWSE area to prevent the installation of new drinking water wells. A groundwater ordinance is an effective means to restrict the future use of groundwater for drinking that could result in exposure in an area or on individual properties. ▪ A deed restriction limiting the use of groundwater is currently in place for the	▪ The MWSE was conducted as a Response Action, providing an alternate water source to a large area. The Respondents have provided the MWSE in the Area of Investigation as shown on Figure 3 in accordance with AOC I and the Amendment to AOC I. The residential areas downgradient of Yard 520 are connected and served by the public water supply. The public water supply could be extended to the area of MW111 or MW122 in the event of residential or commercial development in those wetland areas. ▪ Applying a deed restriction to certain properties within the Area of Investigation requires each restriction to be approved by the property owner, and potential resistance to the restriction could occur. In addition, if restrictions were to be considered over a relatively large area, it may be	**Retained** ▪ The MWSE was implemented as a Response Action. ▪ Institutional controls (i.e., deed restriction and/or groundwater ordinance) for the Area of Investigation to restrict the future use of groundwater for drinking would be an effective means to control future drinking water exposures. ▪ Institutional controls in the form of deed restrictions have been implemented at Yard 520 and will be retained. ▪ Alternate institutional controls will be considered. **Eliminated** ▪ Extending the municipal water service to other areas is not retained as an option

Basic Operating Principle / Alternative	Example Technologies	Effectiveness	Implementability	Screening Status
		property on which Yard 520 is located. ▪ If groundwater restrictions were to become necessary on properties outside the MWSE, individual deed restrictions on each property could be considered. Such deed restrictions are also effective means to restrict the future use of groundwater for drinking on individual properties. ▪ Alternate institutional controls could be effective measures to support groundwater use restrictions or other activities. These may consist of: a periodic well survey to ensure that no new wells have been installed; and/or periodic review with the Town and/or County to review if any well installation permits have been issued for the area.	challenging to contact and obtain timely approval from the owners of the many small, undeveloped lots. ▪ Establishing a groundwater ordinance would require Town and/or County officials to establish the legal mechanism. ▪ Given the active community involvement, implementing a deed restriction or groundwater use ordinance may be challenging.	because groundwater within these areas meets RAOs. ▪ The provision of bottled water is eliminated from further consideration because groundwater within residential areas outside the current MWSE area meets RAOs.
Containment: Cap (Soil / Groundwater)	▪ Engineered Cap; Soil Cover; Other Surficial Covers	▪ Capping is placed over an impacted area to minimize infiltration and mobilization of constituents. Capping would also prevent direct exposure to underlying materials. ▪ An engineered cap is currently in place over Yard 520. Closure plans for Yard 520 were prepared and implemented under IDEM regulatory authority. This cap reduces the source of potential groundwater impacts observed at wells MW-3, MW-6, MW-8, MW-10, TW-12, TW-15D, TW-16D, TW-18D, and MW122. ▪ Placing a cap over other areas within the Area of Investigation (such as areas of CCB fill) would have only limited effectiveness. Many of the areas of CCB fill are Town roads, most of which have already been paved. Capping of the two unpaved roads would be only marginally effective at reducing infiltration and mobility of CCB constituents, because these roads (CCB fill areas) represent only a fraction of the areas	▪ Yard 520 is capped and so this Remedial Action has already been implemented. ▪ Although paving two unpaved roads would be done using standard and available construction equipment, placing a cap over other areas within the Area of Investigation (such as areas of CCB fill) would be difficult and provide implementation challenges, including capping in wetland areas, capping residential or industrial properties, and regulatory permitting. ▪ Capping areas where CCB-derived constituents are present at the ground surface at concentrations greater than background and associated with risks within and/or above USEPA's target risk range of 10^{-6} to 10^{-4} and a target endpoint-specific hazard index of 1 is not	**Retained** ▪ Yard 520 has been capped in accordance with IDEM regulations. Post-Closure plans have been approved by IDEM, and are currently being implemented. ▪ Capping will be retained for areas outside of Yard 520 where CCB fill may be causing migration of CCB-derived constituents to groundwater. ▪ Capping will be retained for areas where CCB-derived constituents are present at the ground surface at concentrations greater than background and associated with risks within and/or above USEPA's target risk range of 10^{-6} to 10^{-4} and a

Basic Operating Principle / Alternative	Example Technologies	Effectiveness	Implementability	Screening Status
		where infiltration takes place. ▪ Capping areas where CCB-derived constituents are present at the ground surface at concentrations greater than background and associated with risks within and/or above USEPA's target risk range of 10^{-6} to 10^{-4} and a target endpoint-specific hazard index of 1 could be an effective means to prevent direct contact exposure to these constituents.	difficult to implement from an engineering perspective. However, many of these areas would be on private property, and individual property owners, who have ownership liability, might refuse access. ▪ Suitable fill must be obtained that can be shown to have concentrations below background, within or below the target risk levels as defined above, and below concentrations in the material it is replacing. ▪ Property acquisition may be required.	target endpoint-specific hazard index of 1.
Containment: Passive (Groundwater)	▪ Physical (Vertical) Barrier o Slurry Wall o Sheet Pile Wall	▪ Yard 520 is currently regulated under IDEM and is in compliance with the applicable Indiana Regulations and with the terms of its Post Closure Permits issued under those Regulations. Further actions at Yard 520 under CERCLA would need to be warranted under the National Contingency Plan. ▪ Six years of available data indicate that the current extent of CCB-derived COCs in groundwater is contained. However, the containment option may be effective at reducing possible future migration and potentially reducing the extent of the impacted area. ▪ Passive groundwater containment could be effective in reducing future migration of CCB-derived COCs to groundwater in certain areas of the Area of Investigation, and therefore reduce COC concentrations over time. However, Yard 520, as well as much of the eastern part of the Area of Investigation, is situated at the top of the groundwater divide, and a barrier could	▪ The installation of a vertical barrier to contain future migration of CCB-related COCs to groundwater in certain areas of the Area of Investigation would be extensive and labor intensive, because a barrier may span lengths of up to 2,000 feet making it difficult to construct. ▪ A barrier that contained the area where cumulative risk screening results exceed the USEPA target risk range of 10^{-6} to 10^{-4} and a target endpoint-specific HI of 1 for the drinking-water pathway would be very disruptive to the community on a day to day basis during installation and operation. ▪ The cost of a large barrier would likely be greater than the benefits provided. Access to private property to complete the installation of a barrier would be necessary and may be difficult to obtain.	**Retained** ▪ The current extent of CCB-related COCs in groundwater is contained (6 years of available data indicate the COC extent is not expanding). ▪ Containment of certain areas of the Area of Investigation would not significantly reduce risk, as groundwater quality would not be improved within the contained area. ▪ Areas downgradient from the containment may improve over time, but may also stagnate, extending the time frame for those areas to flush. Such stagnation could be problematic as there are active septic inputs in this area.

Basic Operating Principle / Alternative	Example Technologies	Effectiveness	Implementability	Screening Status
		create a stagnant zone of groundwater that would require an extremely long period of time to flush; this area is north of Yard 520 with many active septic inputs.	▪ The barrier would need to be installed within a wetland area; installation of such a barrier would be extremely disruptive to the wetland habitat, and significant effort would be required to conduct such work (including meeting the substantive requirements of necessary permits). ▪ A barrier along the north and west sides of Yard 520 would divert groundwater flow toward Brown Ditch and control groundwater that would otherwise flow north of HWY 20 ▪ Groundwater north of HWY 20 (down-gradient from the barrier) would be allowed to flow naturally to Brown Ditch. ▪ A containment approach would require institutional controls.	
Containment: Active (Groundwater)	▪ PRB ▪ Hydraulic Barrier by Groundwater Extraction ▪ Phytoremediation	▪ Yard 520 is currently regulated under IDEM and is in compliance with the applicable Indiana Regulations and with the terms of its Post Closure Permits issued under those Regulations. Further actions at Yard 520 under CERCLA would need to be warranted under the National Contingency Plan. ▪ The current extent of CCB-derived COCs in groundwater is contained (6 years of available data indicate the COC extent is not expanding). PRB ▪ PRBs have been installed to address a number of groundwater constituents, but not the suite of CCB-derived COCs. Hydraulic Barrier ▪ Installation of a row of groundwater	PRB ▪ Installation of a PRB is impractical because of the length of wall required to ensure effectiveness (spanning locations where CCB-derived COCs are present), disruption to residents, and presence of wetlands. Hydraulic Barrier ▪ Operation and maintenance of a groundwater containment system would be required for an extended period of time, and would require treatment of large quantities of extracted groundwater. The discharge location of treated water would need to be determined.	**Retained** ▪ The option of a hydraulic barrier has been retained and may be effective in managing dissolved CCB-derived COCs in the Area of Investigation. However, the lack of implementability due to extensive effort, high cost, management of large volumes of water, and continual O&M make these options undesirable (especially with regard to the PRB and hydraulic barrier Options), but they have the potential to reduce risk. ▪ Phytoremediation may

Basic Operating Principle / Alternative	Example Technologies	Effectiveness	Implementability	Screening Status
		extraction wells along the downgradient areas could capture groundwater, and would require subsequent treatment and disposal. ▪ This option could be effective in capturing groundwater in certain locations, and reduce CCB-related COC concentrations within the Area of Investigation. Phytoremediation ▪ This option could be effective in extracting CCB-derived COCs from groundwater.	▪ Installation of a groundwater extraction system would require infrastructure installation, excavation in wetlands, groundwater treatment, and disposal. Significant effort would be required to conduct such work (including meeting the substantive requirements of necessary permits, especially in a wetland area). ▪ This option may require property acquisition prior to installation. Phytoremediation ▪ This option may provide benefits in the way of improved quality of the wetland ecology. ▪ Monitoring, harvesting/landfilling biomass would be conducted. ▪ Acquisition of the property may be required. ▪ This would not be an option for Yard 520, due to the presence of the cap.	provide benefits in addition to groundwater quality improvement.
Ex Situ Treatment Groundwater Removal/ Treatment (Groundwater)	▪ Groundwater Extraction and Treatment	▪ Yard 520 is currently regulated under IDEM and is in compliance with the applicable Indiana Regulations and with the terms of its Post Closure Permits issued under those Regulations. Further actions at Yard 520 under CERCLA would need to be warranted under the National Contingency Plan. ▪ Groundwater extraction of source water, particularly from the area immediately surrounding Yard 520 could be effective at reducing groundwater concentrations off the Yard 520 property. ▪ Extraction of groundwater would reduce dissolved-phase constituents where implemented in the Area of Investigation, but this technology is only effective when the	▪ Operation and maintenance of a groundwater extraction and treatment system would be required for an extended period of time, and would require treatment of large quantities of extracted groundwater. ▪ Installation of a groundwater extraction system would require infrastructure installation, excavation in wetlands, groundwater treatment, and disposal. Significant effort would be required to conduct such work (including meeting the substantive requirements of necessary permits, especially in a wetland area).	**Retained** ▪ Extraction of groundwater is not effective for reducing concentrations throughout a large area and is efficient when the source of impacts is also removed. However, this method may be able to achieve RAOs, and is therefore retained for further evaluation in the FS.

Basic Operating Principle / Alternative	Example Technologies	Effectiveness	Implementability	Screening Status
		source of impacts is also removed. A continual source would necessitate continual operation and maintenance of the groundwater treatment system. Therefore, long-term remedial options may require an alternate technology. ▪ Extracted groundwater can be effectively treated for most parameters, although treatment for boron would be complex (ion exchange/reverse osmosis). ▪ Discharge options include to Brown Ditch, to a public treatment works (e.g., wastewater treatment plant), or reinjection into the groundwater. In most cases, discharge of extracted groundwater is a logistical challenge.	▪ Treatment of boron ex-situ is a complicated process because boron's high solubility requires a complex treatment system resulting in high cost for treatment (via ion exchange/reverse osmosis) and system maintenance, potential large volumes of water to dispose of, and a large area required to house the treatment system. ▪ Provisions for discharge of potentially large volumes of treated groundwater would have to be made. ▪ This option may require property acquisition prior to installation.	
Ex Situ Treatment Soil Removal (Soil / Groundwater)	▪ CCB Removal	▪ Yard 520 is currently regulated under IDEM and is in compliance with the applicable Indiana Regulations and with the terms of its Post Closure Permits issued under those Regulations. Further actions at Yard 520 under CERCLA would need to be warranted under the National Contingency Plan. ▪ Excavation is a method to permanently remove CCBs and eliminate potential direct contact exposure to CCB-related COCs. By removal, the volume and mobility of CCB-related constituents would be eliminated within the Area of Investigation. ▪ Excavation is an effective method to permanently remove CCBs and eliminate potential mobilization of CCB-derived COCs to groundwater; it is, however, infeasible to remove all CCBs in the Area of Investigation (e.g., under roads, within Yard 520, etc.). ▪ Options for managing excavated materials include 1) on-site treatment, which may require permitting for the siting and operation of the treatment facility, with off-site disposal	▪ Removal at selected locations of CCBs is potentially feasible (e.g., residential yards, schools, churches, and playgrounds), where it is demonstrated to be warranted. ▪ An option associated with institutional controls would be to require the removal of CCBs beneath roads or portions of roads (i.e., utility trenches) and replacement with clean fill as part of maintenance activities. ▪ Obtaining backfill that contains constituents at levels below background levels, below risk targets, or below the levels in material it is replacing, may be challenging. ▪ Implementation of this option would require removal and potential dewatering of subsurface soil in certain locations. ▪ Excavation in the wetland areas	**Eliminated** ▪ Excavation of CCBs at Yard 520. **Retained** ▪ While excavation of all CCBs outside Yard 520 is infeasible, excavation of certain surficial areas of CCB fill is retained because it would eliminate potential direct contact exposure to CCB-derived COCs. However, the availability of clean fill (i.e., that has constituent concentrations below background and below the material being replaced and within or below risk targets) may preclude this option.

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Basic Operating Principle / Alternative	Example Technologies	Effectiveness	Implementability	Screening Status
		or 2) off-site treatment and disposal involving transport of excavated materials to an appropriate facility.	would cause significant disruption in certain areas and require IDEM regulatory approval and meeting permit requirements of the United States Army Corps of Engineers. ▪ Because CCBs are non-hazardous materials, management of the excavated material should not pose significant implementation challenges. However, the volume of excavated material may make this option challenging. ▪ No long-term maintenance would be required with this technology.	
In Situ Treatment MNA (Groundwater)	▪ MNA	▪ MNA would be effective in reducing mobility of many CCB-derived COCs in groundwater within the existing plume areas. The CCBs present in the Area of Investigation are a source of CCB-derived COCs, but have been shown with 6 years of existing data to migrate a limited distance in the aquifer. Natural attenuation mechanisms are present within the aquifer and are reducing the concentrations of many CCB-derived constituents downgradient from areas of CCB fill. ▪ A monitoring program would provide an effective means to monitor aquifer conditions to document progress of MNA.	▪ Monitoring of natural attenuation processes and the overall concentrations of CCB-derived COCs within the Area of Investigation is implementable. ▪ Access agreements may be required or existing agreements extended for monitoring locations on private property.	**Retained** ▪ The MNA option is retained because it could be effective in reducing concentrations and/or mobility of many CCB-derived COCs in groundwater within the existing plume areas.
Other *In Situ* Treatment (Soil / Groundwater)	▪ Aeration / Volatilization ▪ Thermal	▪ Aeration / volatilization and thermal technologies remove and treat organic compounds and do not treat inorganics, thus these remedial options are not effective.	▪ Aeration / volatilization and thermal technologies do not treat inorganic compounds.	**Eliminated** ▪ These options are not effective at removing CCB-derived COCs.

Basic Operating Principle / Alternative	Example Technologies	Effectiveness	Implementability	Screening Status

Acronyms and Abbreviations:

AOC - Administrative Order on Consent.

bgs - below ground surface.

CCB - Coal Combustion By-product.

CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act.

COC - Constituent of Concern.

FS - Feasibility Study.

HHRA - Human Health Risk Assessment.

HI – Hazard Index.

HWY – Highway.

IDEM - Indiana Department of Environmental Management.

MNA - Monitored Natural Attenuation.

MWSE - Municipal Water Service Extension.

O&M - Operations and Maintenance.

PRB - Permeable Reactive Barrier.

RAO - Response Action Objective.

RI/FS - Remedial Investigation/Feasibility Study.

USEPA – United States Environmental Protection Agency.

TABLE 8
SUMMARY OF REMEDIAL ALTERNATIVES
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING TECHNICAL MEMORANDUM

Basic Operating Principle/Technology	Alternatives								
	GW-1 (a)	GW-2	GW-3	GW-4	GW-5	Soil-1	Soil-2	Soil-3	Soil-4
No Further Action									
▪ Closure of Yard 520 (b)	✓	✓	✓	✓	✓	✓	✓	✓	✓
▪ MWSE (c)	✓	✓	✓	✓	✓				
Land Use Controls:									
▪ Groundwater Ordinance on MWSE area		✓	✓	✓	✓				
▪ Deed Restriction		✓	✓	✓	✓		✓		✓
Monitored Natural Attenuation			✓						
Active Groundwater Treatment				✓					
Passive Groundwater Treatment					✓				
CCB Removal								✓	
Capping									✓

Notes:
"GW-" indicates an Alternative for remediation of Groundwater.
"Soil-" indicates an Alternative for remediation of CCBs.

a) The No Further Action alternative will be carried forward in the Feasibility Study because it is a CERCLA requirement that this alternative be retained as a baseline for comparison with other alternatives.
b) Yard 520 has been closed in accordance with applicable IDEM regulations, and is being maintained in accordance with the approved Post-Closure Plan.
c) The MWSE was completed in 2006; additional extensions to this service have been eliminated from further consideration in the technology screening analysis.

Acronyms and Abbreviations:
CCB - Coal Combustion By-products.
CERCLA - Comprehensive Environmental Response, Compensation and Liability Act.
GW - Groundwater.
IDEM - Indiana Department of Environmental Management.
MWSE - Municipal Water Service Extension.

TABLE 9A
DESCRIPTION OF GROUNDWATER REMEDIAL ALTERNATIVES
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING MEMORANDUM

Basic Operating Principle / Alternative	Technologies to be Evaluated	Design Details	Anticipated Logistical Challenges	Approximate Timeline	Cost
GW Alternative-1 No Further Action	--	▪ MWSE (completed) ▪ Yard 520 closed under IDEM and maintained	▪ None	*Completed* ▪ Note that the MWSE was implemented in 2003/2004, well before the conclusion of the RI/FS for the project.	Total: $6,749,000 for Yard 520 closure, MWSE (1st and additional extensions), bottled water delivery (to 2012), and other associated costs.
GW Alternative-2 Land Use Controls	--	▪ MWSE (completed) ▪ Yard 520 closed under IDEM and maintained ▪ A Groundwater Ordinance is applied to the MWSE area to prevent use of groundwater for drinking water ▪ A deed restriction limiting the use of groundwater is currently in place for the property on which Yard 520 is located ▪ A deed restriction could be applied for other areas to prevent the use of groundwater for drinking purposes	▪ Groundwater Ordinance: May be difficult to implement and will be pending Town/County government approval of the Groundwater Ordinance language. ▪ Deed Restriction Yard 520: none. ▪ Deed Restriction (other areas): Discussions and approvals of the language of the deed restriction will be required from owners of private property, which may be difficult. In addition, if restrictions were to be considered over a relatively large area, based on experience during the RI for access agreements, it may be difficult to identify owners of the many small, undeveloped lots.	*1 - 2 years after USEPA approval*: Implement. *Long-term:* Maintain institutional controls.	Low

TABLE 9A
DESCRIPTION OF GROUNDWATER REMEDIAL ALTERNATIVES
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING MEMORANDUM

Basic Operating Principle / Alternative	Technologies to be Evaluated	Design Details	Anticipated Logistical Challenges	Approximate Timeline	Cost
GW Alternative-3 Monitored Natural Attenuation (MNA)	--	▪ MWSE (completed) ▪ Yard 520 closed under IDEM and maintained ▪ A Groundwater Ordinance is applied to the MWSE area to prevent use of groundwater for drinking water ▪ A deed restriction limiting the use of groundwater is currently in place for the property on which Yard 520 is located ▪ A deed restriction could be applied for other areas to prevent the use of groundwater for drinking purposes ▪ Periodic monitoring to evaluate the results for natural attenuation processes and changes in conditions ▪ The monitoring program would supplement the data collected for the current Yard 520 monitoring program	▪ Potential issues with installing wells on private property and/or within wetlands.	*3 - 6 months after USEPA approval:* Initial design to determine sampling locations, parameter lists and monitoring frequency. *6 months - 1 year:* Install wells if needed and conduct initial MNA monitoring event. *Long-term:* Conduct monitoring and data evaluation. Evaluation of data results will include assessment for plan adjustments.	Medium

TABLE 9A
DESCRIPTION OF GROUNDWATER REMEDIAL ALTERNATIVES
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING MEMORANDUM

Basic Operating Principle / Alternative	Technologies to be Evaluated	Design Details	Anticipated Logistical Challenges	Approximate Timeline	Cost
GW Alternative-4 Active Treatment	Permeable Reactive Barrier (PRB)	▪ MWSE (completed) ▪ Yard 520 closed under IDEM and maintained ▪ A Groundwater Ordinance is applied to the MWSE area to prevent use of groundwater for drinking water ▪ A deed restriction limiting the use of groundwater is currently in place for the property on which Yard 520 is located ▪ A deed restriction could be applied for other areas to prevent the use of groundwater for drinking purposes ▪ Installation downgradient of Yard 520 ▪ Groundwater monitoring	▪ Reactive media that will treat boron are limited; recent research indicates coal and fly ash are capable of supplying advective surfaces for boron removal. ▪ Installation in areas other than Yard 520 (private property, public road ways, utility corridors) will present implementation challenges, including access, service disruption, etc. ▪ May require property acquisition.	*1 - 3 years after USEPA approval*: Implement *Long-term*: Monitor groundwater flow and downgradient quality. Maintain institutional controls.	High

TABLE 9A
DESCRIPTION OF GROUNDWATER REMEDIAL ALTERNATIVES
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING MEMORANDUM

Basic Operating Principle / Alternative	Technologies to be Evaluated	Design Details	Anticipated Logistical Challenges	Approximate Timeline	Cost
	Hydraulic Barrier	▪ MWSE (completed) ▪ Yard 520 closed under IDEM and maintained ▪ A Groundwater Ordinance is applied to the MWSE area to prevent use of groundwater for drinking water ▪ A deed restriction limiting the use of groundwater is currently in place for the property on which Yard 520 is located ▪ A deed restriction could be applied for other areas to prevent the use of groundwater for drinking purposes ▪ Groundwater extraction from low-capacity pumping wells along the downgradient boundary of Yard 520 to control the groundwater gradient ▪ Construct a treatment facility in the vicinity of Yard 520, to include treatment methods for COCs ▪ Discharge to surface water and/or infiltration ▪ Groundwater monitoring	▪ Treatment technology may not be effective to treat the low concentrations of boron reported in the groundwater or to permit direct surface application of treated groundwater to the wetland under a NPDES permit. ▪ Maintenance of the pumping and treatment systems will likely be intensive due to high native iron and manganese content in the groundwater. ▪ Organics from septic waste or other sources of groundwater contamination within the capture zone may necessitate additional treatment prior to discharge. ▪ May require property acquisition.	*1 – 3 years after USEPA approval*: Implement. *Long-term*: Maintain wells, pumps, and treatment system components. Monitor groundwater flow and downgradient quality. Maintain institutional controls.	High

TABLE 9A
DESCRIPTION OF GROUNDWATER REMEDIAL ALTERNATIVES
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING MEMORANDUM

Basic Operating Principle / Alternative	Technologies to be Evaluated	Design Details	Anticipated Logistical Challenges	Approximate Timeline	Cost
	Phytoremediation	▪ MWSE (completed) ▪ Yard 520 closed under IDEM and maintained ▪ A Groundwater Ordinance is applied to the MWSE area to prevent use of groundwater for drinking water ▪ A deed restriction limiting the use of groundwater is currently in place for the property on which Yard 520 is located ▪ A deed restriction could be applied for other areas to prevent the use of groundwater for drinking purposes ▪ Replacement of existing vegetation in specific downgradient areas with selected plants capable of extracting COCs ▪ Routine monitoring and harvesting of dead/damaged biomass; landfill disposal ▪ Groundwater monitoring	▪ May require property acquisition. ▪ Will result in substantive changes to existing wetland ecology and may affect wetland hydrology. ▪ Meeting the substantive requirements of necessary permits will be required.	*0.5 - 2 year after USEPA approval*: Implement. *Long-term*: Monitor groundwater quality. Maintain institutional controls.	Medium

TABLE 9A
DESCRIPTION OF GROUNDWATER REMEDIAL ALTERNATIVES
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING MEMORANDUM

Basic Operating Principle / Alternative	Technologies to be Evaluated	Design Details	Anticipated Logistical Challenges	Approximate Timeline	Cost
	Groundwater Removal/Treatment	▪ MWSE (completed) ▪ Yard 520 closed under IDEM and maintained ▪ A Groundwater Ordinance is applied to the MWSE area to prevent use of groundwater for drinking water ▪ A deed restriction limiting the use of groundwater is currently in place for the property on which Yard 520 is located ▪ A deed restriction could be applied for other areas to prevent the use of groundwater for drinking purposes ▪ Groundwater extraction from pumping wells along the downgradient boundary of Yard 520 to restore the downgradient aquifer to beneficial use ▪ Construct a treatment facility in the vicinity of Yard 520, to include treatment methods for COCs ▪ Discharge to surface water and/or infiltration ▪ Groundwater monitoring	▪ Treatment technology may not be effective to treat the low concentrations of boron reported in the groundwater or to permit direct surface application of treated groundwater to the wetland under a NPDES permit. ▪ Maintenance of the pumping and treatment systems will likely be intensive due to high native iron and manganese content in the groundwater. ▪ Organics from septic waste or other sources of groundwater contamination within the capture zone may necessitate additional treatment prior to discharge. ▪ May require property acquisition.	*1 - 3 years after USEPA approval*: Implement. *Long-term*: Maintain wells, pumps, and treatment system components. Monitor groundwater flow and downgradient quality. Maintain institutional controls.	High

TABLE 9A
DESCRIPTION OF GROUNDWATER REMEDIAL ALTERNATIVES
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING MEMORANDUM

Basic Operating Principle / Alternative	Technologies to be Evaluated	Design Details	Anticipated Logistical Challenges	Approximate Timeline	Cost
GW Alternative-5 Passive Treatment	Cap	▪ MWSE (completed) ▪ Yard 520 closed under IDEM and maintained; capping Yard 520 (completed) ▪ A Groundwater Ordinance is applied to the MWSE area to prevent use of groundwater for drinking water ▪ A deed restriction limiting the use of groundwater is currently in place for the property on which Yard 520 is located ▪ A deed restriction could be applied for other areas to prevent the use of groundwater for drinking purposes	▪ None.	*Completed* ▪ Note that the MWSE was implemented in 2003/2004, well before the conclusion of the RI/FS for the project.	MWSE: $5,255,000 Yard 520 Closure (including cap):$1,524,000 Total: $6,749,000

TABLE 9A
DESCRIPTION OF GROUNDWATER REMEDIAL ALTERNATIVES
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING MEMORANDUM

Basic Operating Principle / Alternative	Technologies to be Evaluated	Design Details	Anticipated Logistical Challenges	Approximate Timeline	Cost
	Wall	▪ MWSE (completed) ▪ Yard 520 closed under IDEM and maintained ▪ A Groundwater Ordinance is applied to the MWSE area to prevent use of groundwater for drinking water ▪ A deed restriction limiting the use of groundwater is currently in place for the property on which Yard 520 is located ▪ A deed restriction could be applied for other areas to prevent the use of groundwater for drinking purposes ▪ Installation of a physical barrier, consisting of bentonite-clay slurry or sheet pile wall around selected portions of Yard 520 ▪ Key wall into underlying clay and other existing containment features at Yard 520 (e.g., cap)	▪ Installation in areas other than Yard 520 (private property, public road ways, utility corridors) will present implementation challenges, including access, service disruption, etc. ▪ May require property acquisition. ▪ Flow characteristics within Brown Ditch and wetland quality may be adversely affected by restriction and/or diversion of groundwater flow. ▪ The potential for groundwater accumulating within the containment area may necessitate the need for drain installation or pumping/treating groundwater.	*1 - 2 years after USEPA approval* Implement. *Long-term*: Monitor groundwater flow and downgradient quality. Maintain institutional controls.	High

Notes:
CCB - Coal Combustion By-product.
COC - Constituent of Concern.
IDEM - Indiana Department of Environmental Management.
MNA - Monitored Natural Attenuation.
MWSE - Municipal Water Service Extension.
NPDES - National Pollutant Discharge Elimination System.
PRB - Permeable Reactive Barrier.
RI/FS - Remedial Investigation/Feasibility Study.
USEPA - United States Environmental Protection Agency.

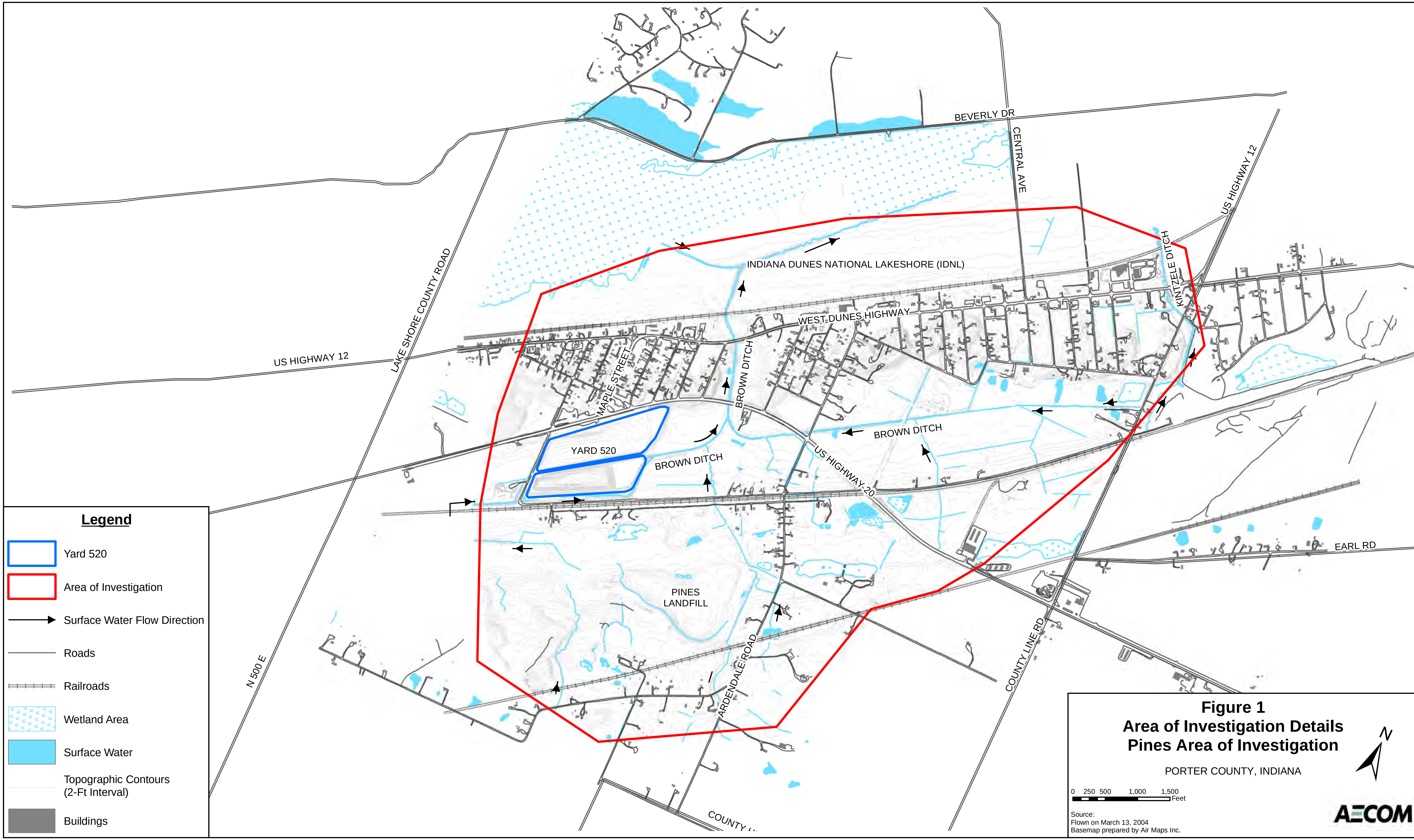
TABLE 9B
DESCRIPTION OF SOIL REMEDIAL ALTERNATIVES
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING MEMORANDUM

Basic Operating Principle/ Alternative	Technologies to be Evaluated	Design Details	Anticipated Logistical Challenges	Approximate Timeline	Cost
Soil Alternative-1 No Further Action	--	▪ Yard 520 closed and maintained under IDEM	▪ None.	*Completed*	$1,524,000 for Yard 520 closure
Soil Alternative-2 Land Use Controls	--	▪ Yard 520 closed and maintained under IDEM ▪ Use of deed restrictions to control risk from exposure to surficial soils.	▪ Deed Restriction Yard 520: none. ▪ Deed Restriction (other areas): Discussions and approvals of the language of the deed restriction will be required from owners of private property, which may be difficult. In addition, if restrictions were to be considered over a relatively large area, based on experience during the RI for access agreements, it may be difficult to identify owners of the many small, undeveloped lots.	*1 - 2 years after USEPA approval*: Implement. *Long-term:* Maintain institutional controls.	Low
Soil Alternative-3 CCB Removal	--	▪ Yard 520 closed and maintained under IDEM ▪ Focused or extensive excavations to remove CCBs to prevent direct exposure to CCB-derived constituents.	▪ Under any excavation alternative, excavation endpoints would need to be established and the extent would need to be determined before an evaluation of this technology can occur. ▪ Soil removal on private property will require an agreement with property owners who have ownership liability and thus might not agree to the terms of an access agreement. ▪ The unavailability of suitable backfill may preclude this option. Suitable fill must be obtained that can be shown to have concentrations below background, within or below the target risk levels as defined above, and below concentrations in the material it is replacing.	*3-6 months after USEPA approval*: Initial design. *Long-term:* Identify and define excavation areas, conduct excavation and backfill operations, and transport and dispose of excavated material at an off-site facility.	Medium to High
Soil Alternative-4 Passive Treatment	Cap	▪ Yard 520 closed and maintained under IDEM ▪ Capping Yard 520 (completed)	▪ None	Completed	$1,524,000 for Yard 520 closure

TABLE 9B
DESCRIPTION OF SOIL REMEDIAL ALTERNATIVES
PINES AREA OF INVESTIGATION
ALTERNATIVES SCREENING MEMORANDUM

Basic Operating Principle/ Alternative	Technologies to be Evaluated	Design Details	Anticipated Logistical Challenges	Approximate Timeline	Cost
Notes: CCB - Coal Combustion By-product. IDEM - Indiana Department of Environmental Management. RI - Remedial Investigation. USEPA - United States Environmental Protection Agency.					

Figures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CENTRAL AVE
US HIGHWAY 12
KINTZELE DITCH
INDIANA DUNES NATIONAL LAKESHORE (IDNL)
WEST DUNES HIGHWAY
LAKE SHORE COUNTY ROAD
US HIGHWAY 12
MAPLE STREET
BROWN DITCH
BROWN DITCH
YARD 520
BROWN DITCH
US HIGHWAY 20
EARL RD
PINES
LANDFILL
ARDENDALE ROAD
COUNTY LINE RD
N 500 E
COUNTY L...
Legend
Yard 520
Area of Investigation
Surface Water Flow Direction
Roads
Railroads
Wetland Area
Surface Water
Topographic Contours
(2-Ft Interval)
Buildings
Figure 1
Area of Investigation Details
Pines Area of Investigation
PORTER COUNTY, INDIANA
0 250 500 1,000 1,500
Feet
N
Source:
Flown on March 13, 2004
Basemap prepared by Air Maps Inc.
AECOM

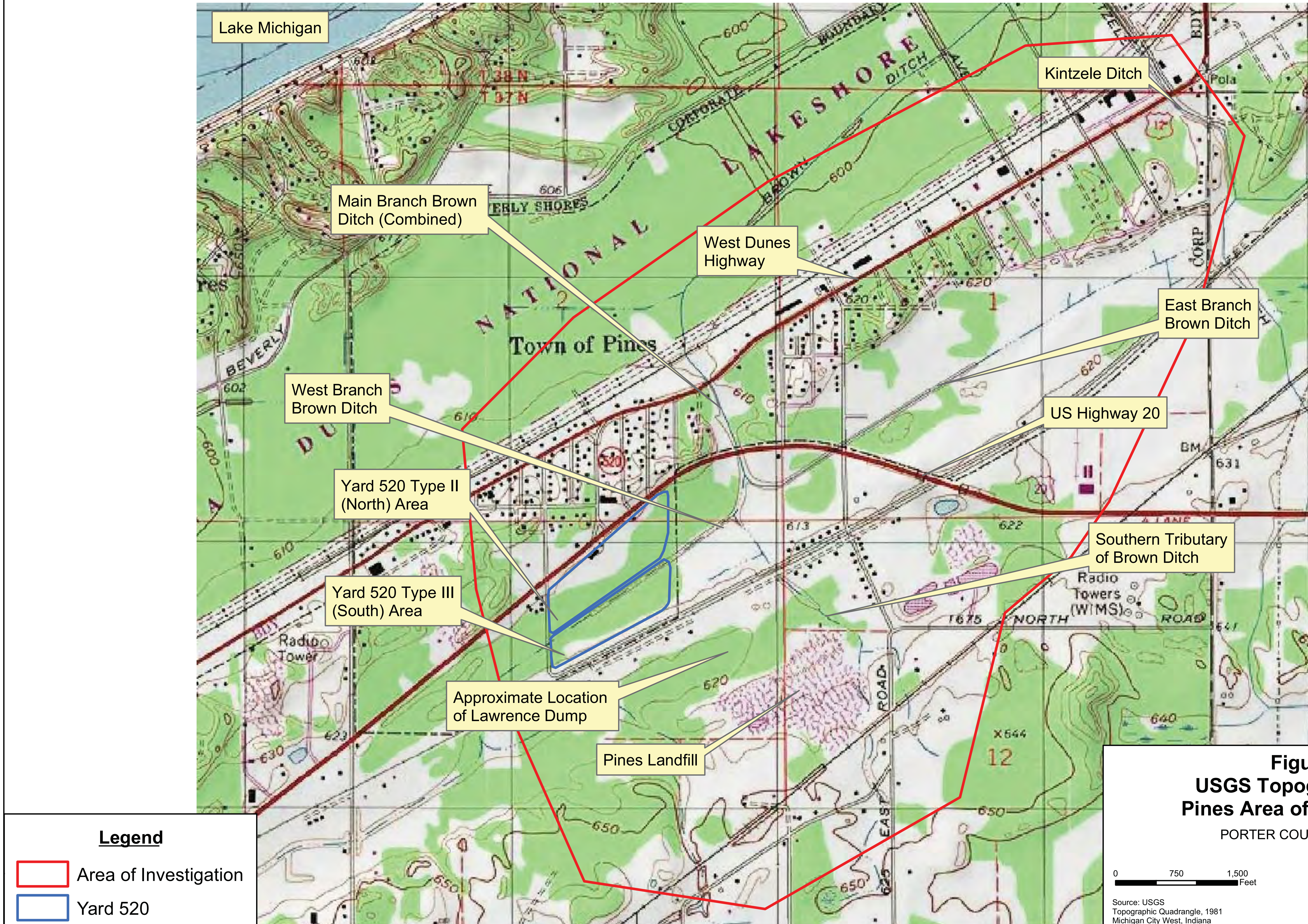


Figure 2
USGS Topographic Map
Pines Area of Investigation
PORTER COUNTY, INDIANA

Source: USGS
Topographic Quadrangle, 1981
Michigan City West, Indiana

AECOM

Legend

- Area of Investigation
- Water service provided under AOC I
- Water service provided under AOC I, Amended
- Line shown indicates roads where bottled water offered under AOC I, Amended.

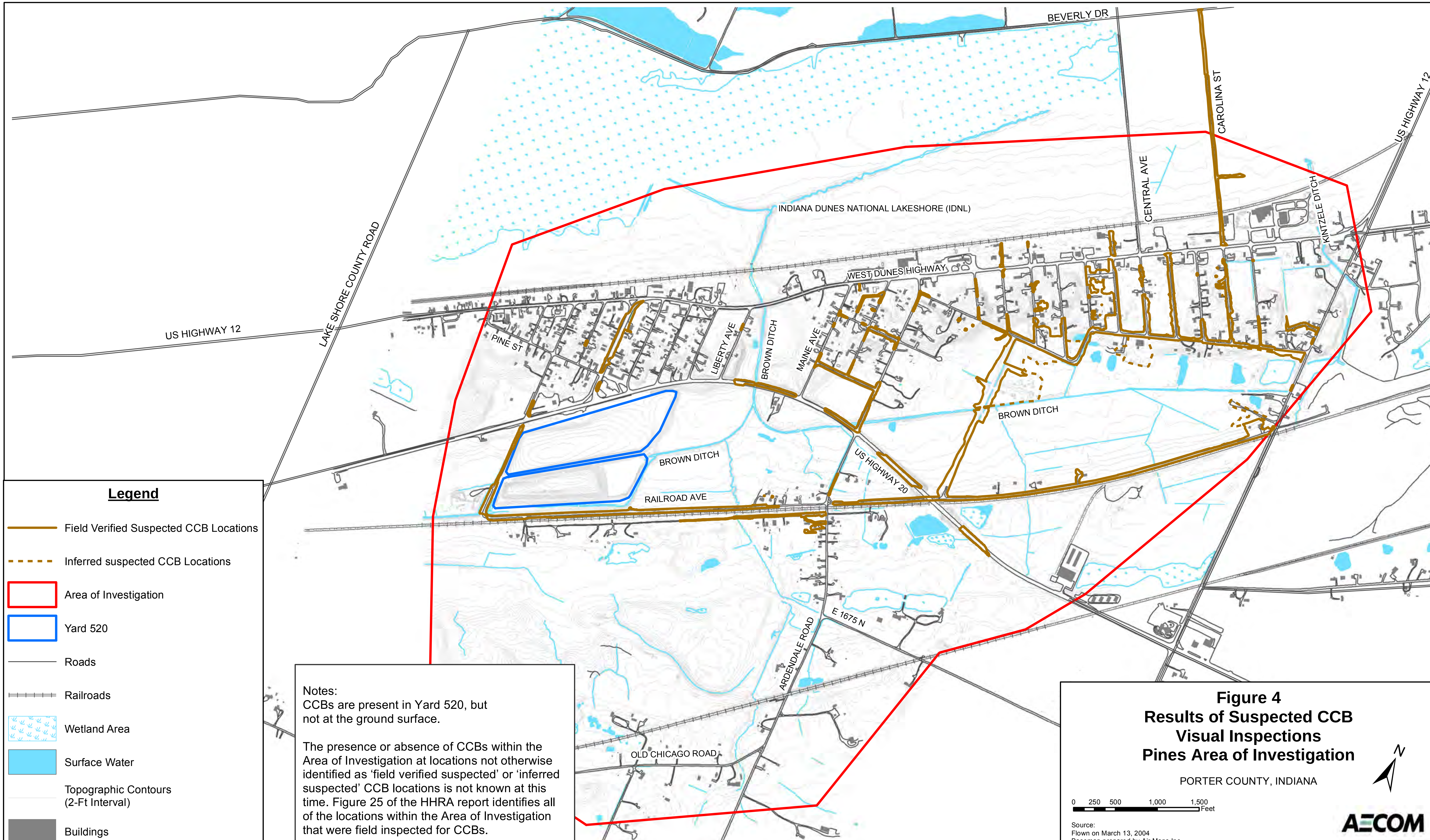
Figure 3
Areas Addressed Under AOCs
Pines Area of Investigation
PORTER COUNTY, INDIANA

0 400 800 1,600 2,400 Feet

N

Source:
Flown on March 13, 2004
Basemap prepared by Air Maps Inc.

AECOM



Legend

- Field Verified Suspected CCB Locations
- Inferred suspected CCB Locations
- Area of Investigation
- Yard 520
- Roads
- Railroads
- Wetland Area
- Surface Water
- Topographic Contours (2-Ft Interval)
- Buildings

Notes:
CCBs are present in Yard 520, but not at the ground surface.

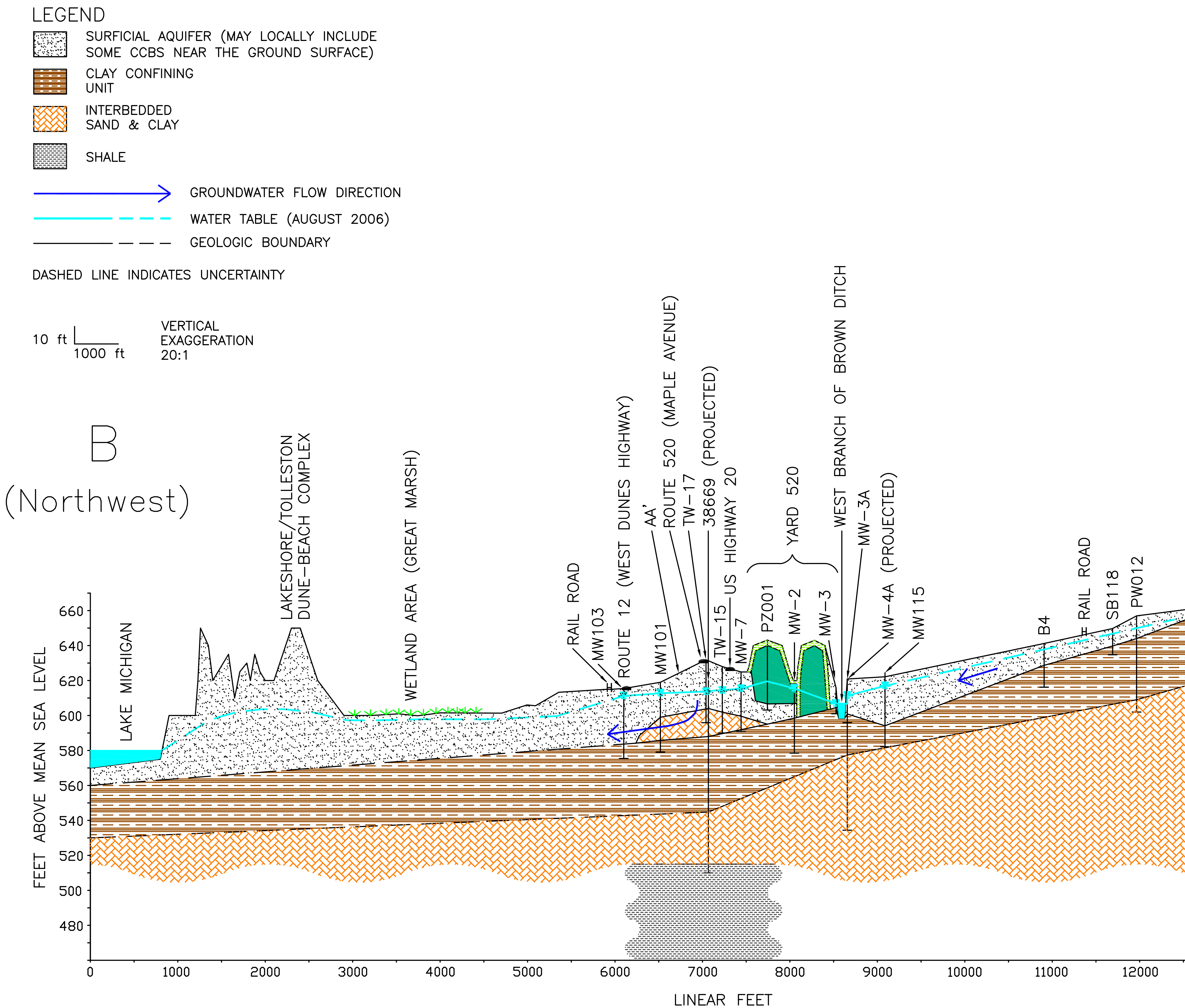
The presence or absence of CCBs within the Area of Investigation at locations not otherwise identified as 'field verified suspected' or 'inferred suspected' CCB locations is not known at this time. Figure 25 of the HHRA report identifies all of the locations within the Area of Investigation that were field inspected for CCBs.

Figure 4
Results of Suspected CCB Visual Inspections Pines Area of Investigation

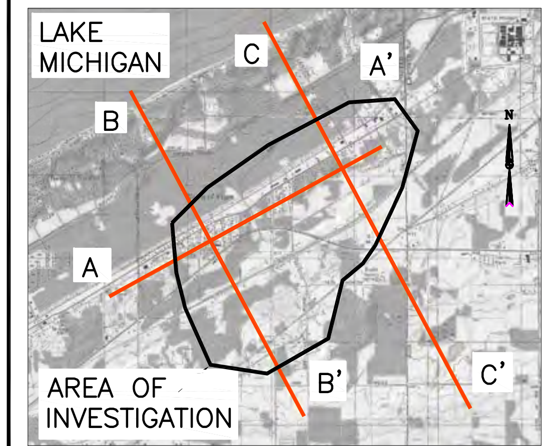
PORTER COUNTY, INDIANA

Source:
Flown on March 13, 2004
Basemap prepared by Air Maps Inc.

AECOM



CROSS SECTION LOCATIONS



REVISIONS

NO.:	DESCRIPTION:	DATE:	BY:

DESIGNED BY:	DRAWN BY:	CHECKED BY:	APPROVED BY:
EP	KM	MD	EP

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CROSS SECTION B–B'

PINES AREA OF INVESTIGATION

PORTER COUNTY, INDIANA

PROJECT NUMBER:	DATE:	SCALE:
10785004	DEC 08	–

FIGURE NUMBER: 5

SHEET NUMBER: 2

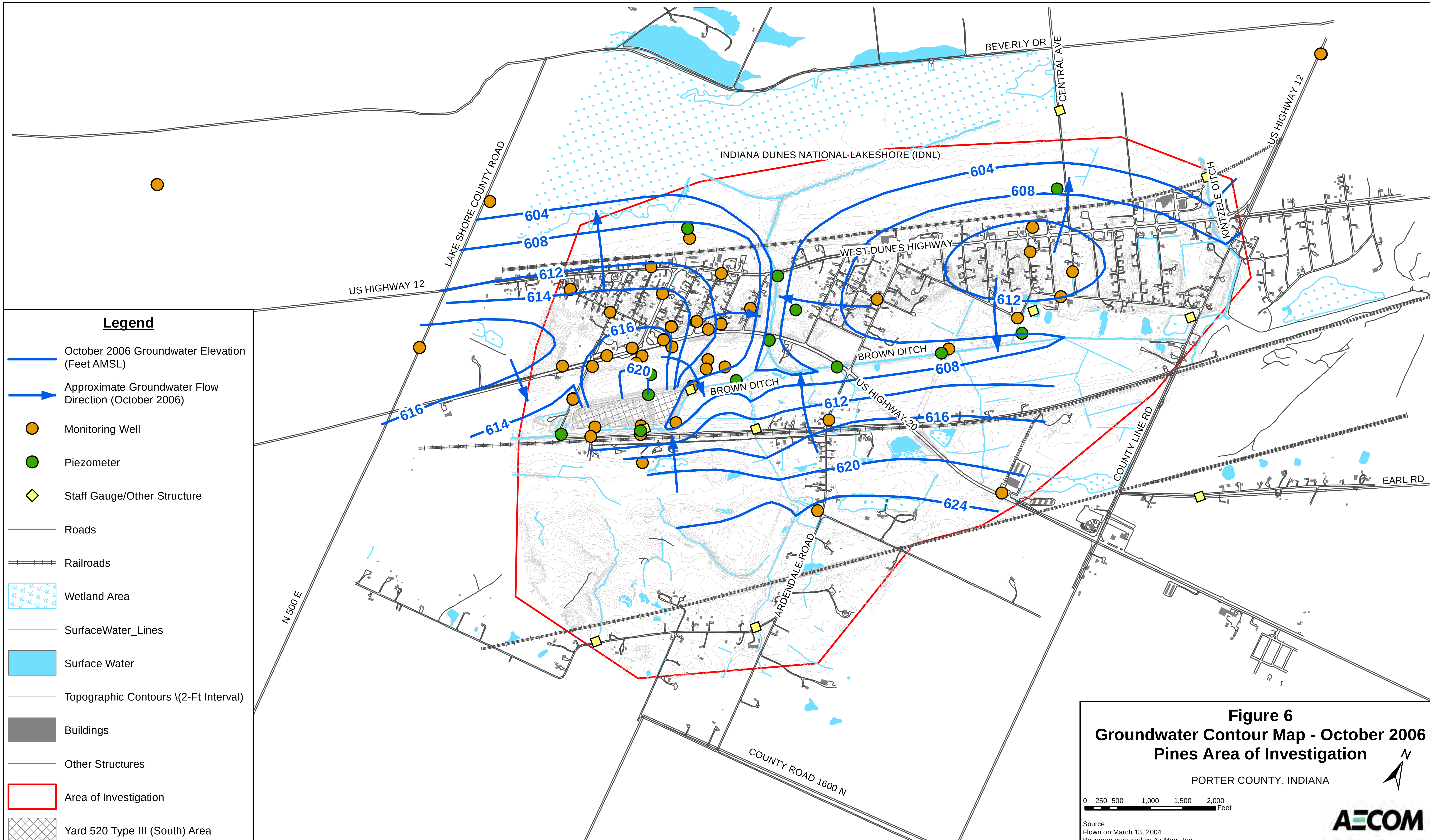
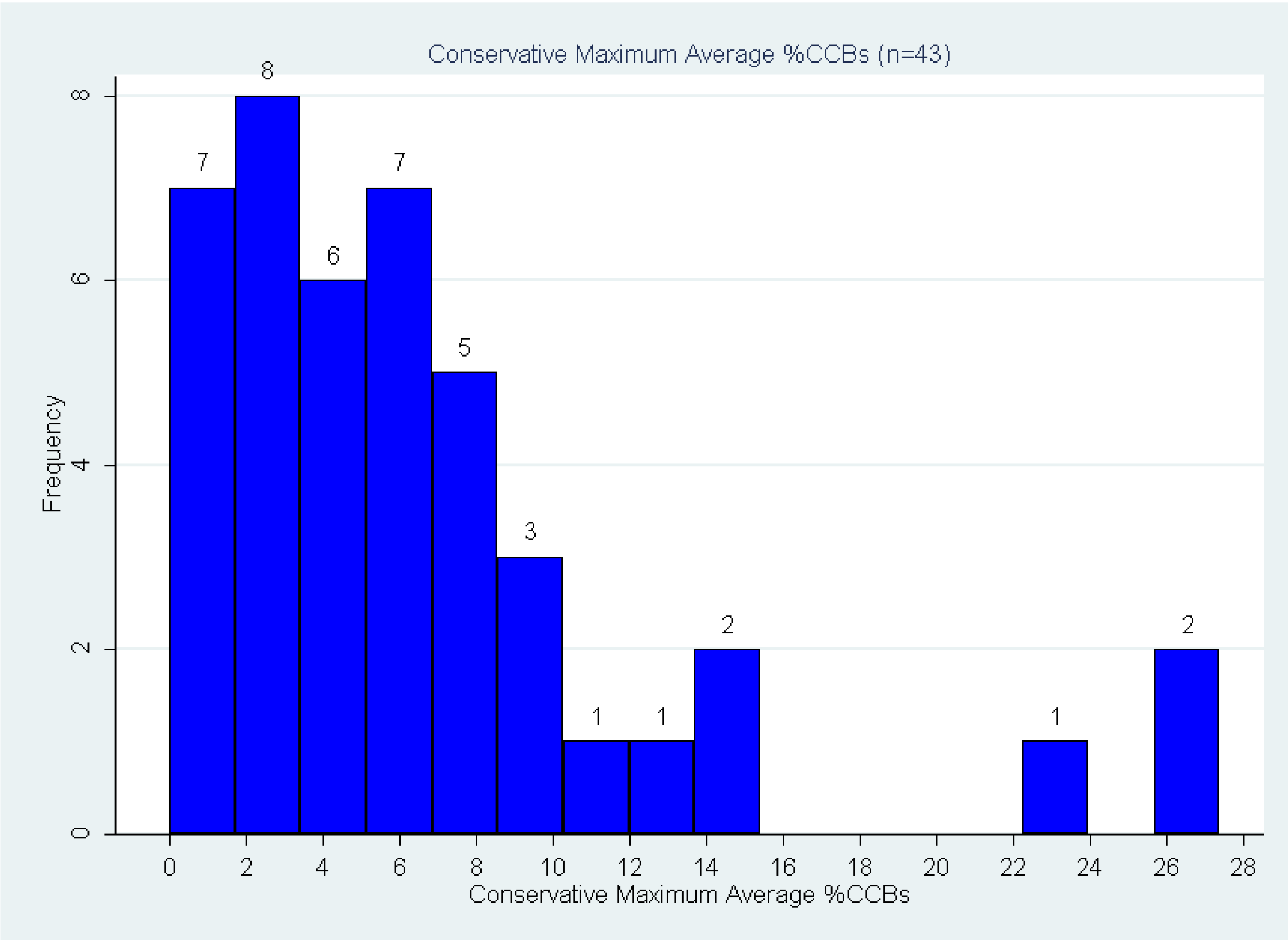
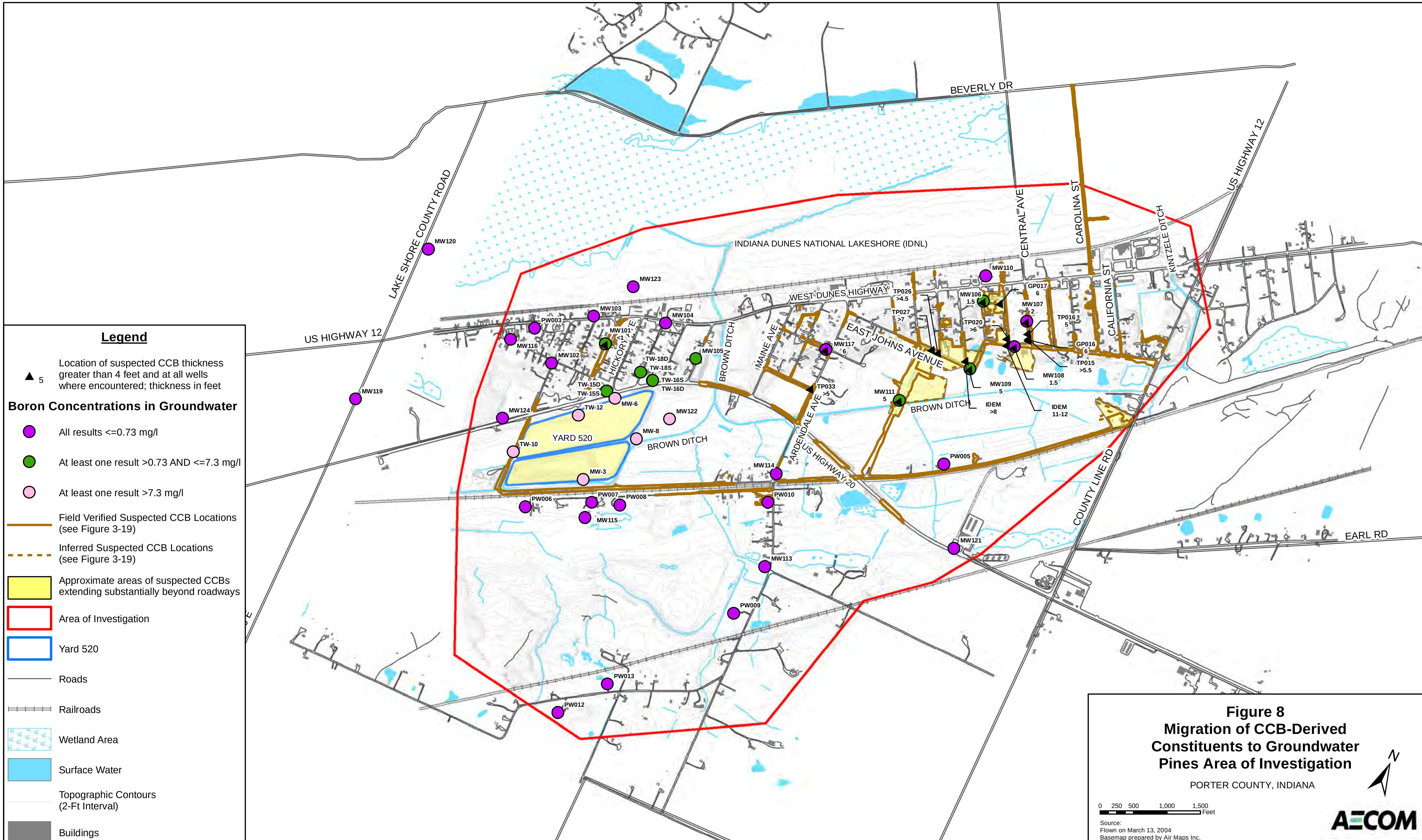
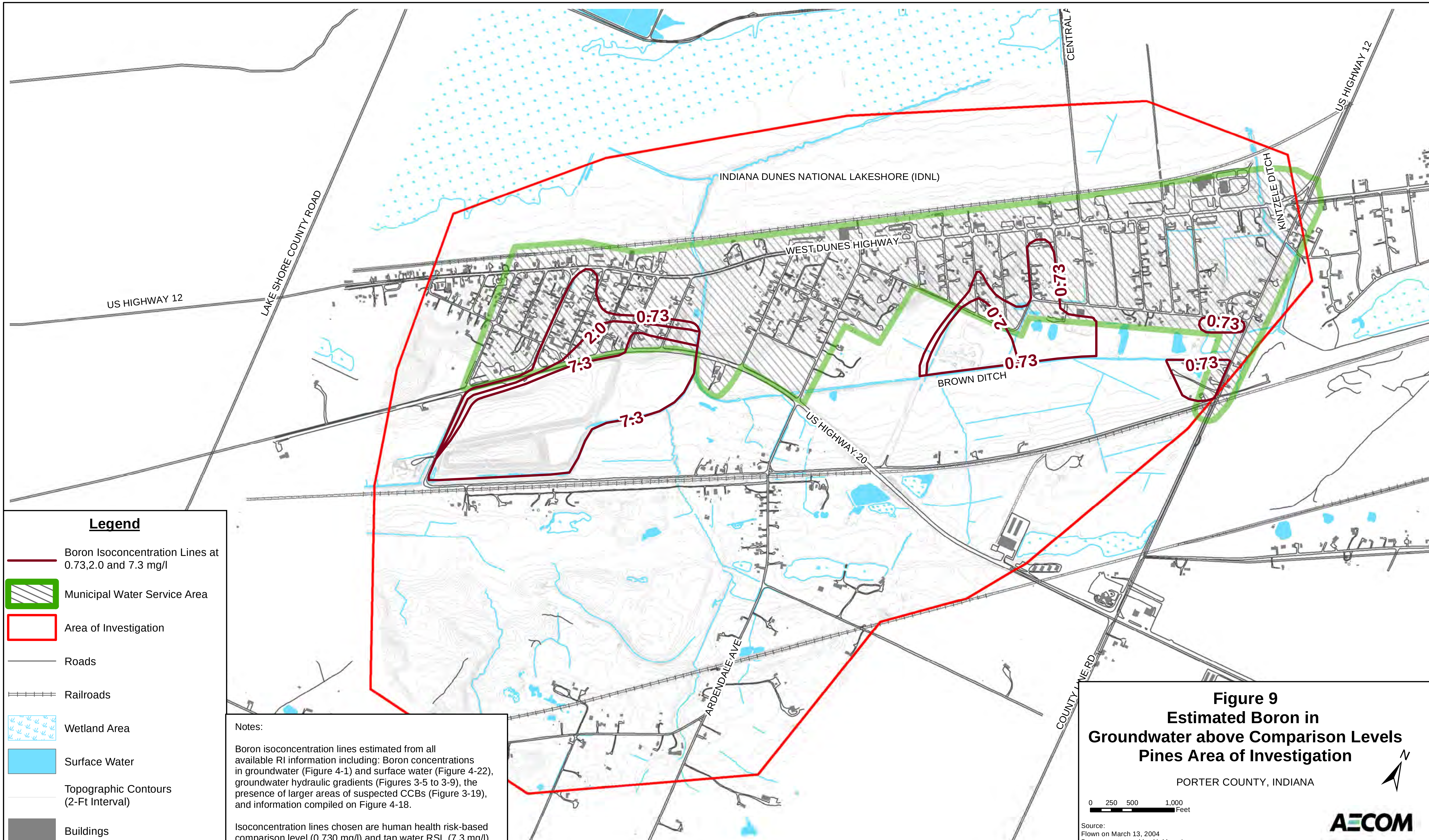
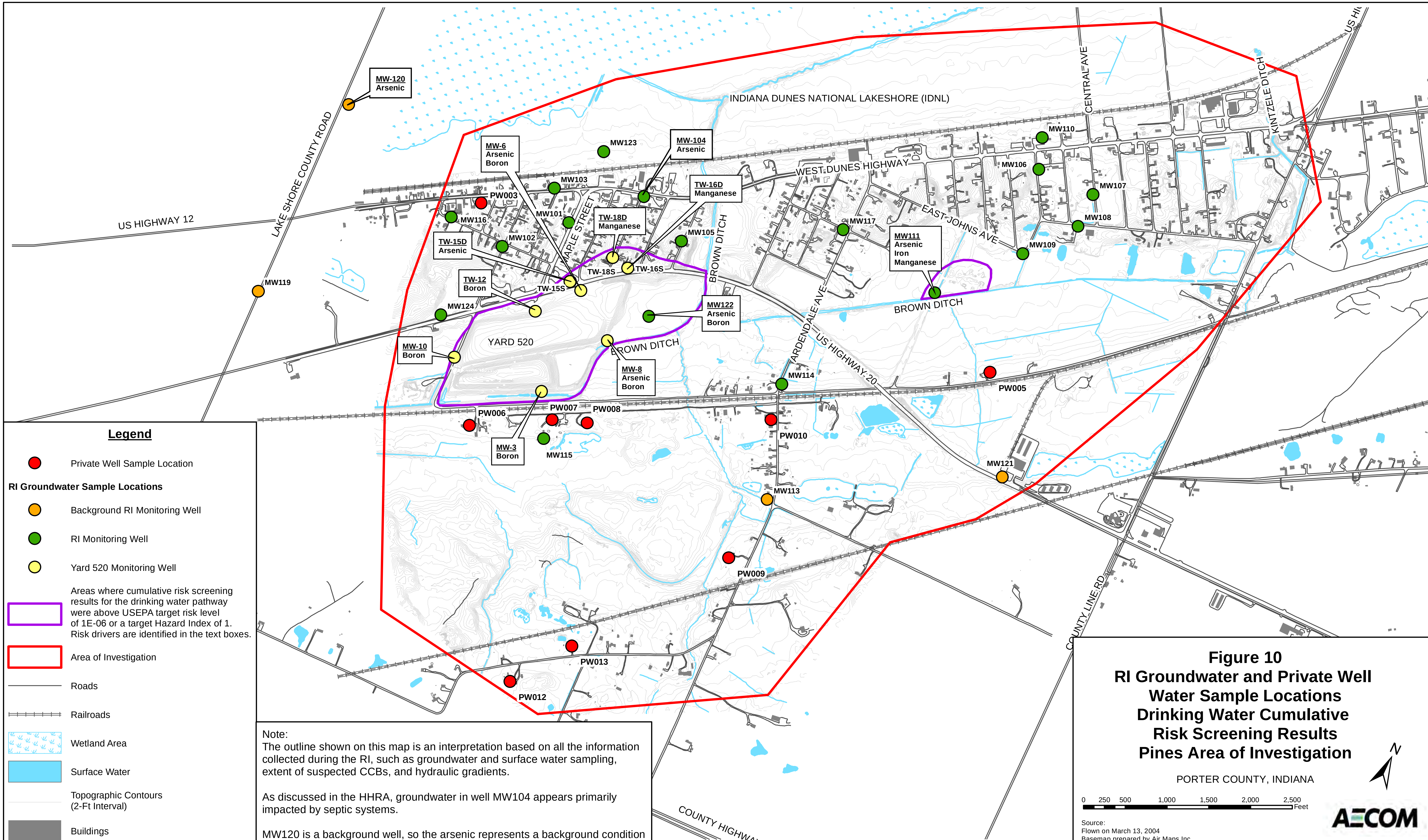

BEVERLY DR
CENTRAL AVE
US HIGHWAY 12
INDIANA DUNES NATIONAL LAKESHORE (IDNL)
LAKE SHORE COUNTY ROAD
KINTZELE DITCH
WEST DUNES HIGHWAY
BROWN DITCH
US HIGHWAY 20
COUNTY LINE RD
EARL RD
ARDENDALE ROAD
COUNTY ROAD 1600 N
N 500 E
604
608
612
614
616
620
624
Legend
October 2006 Groundwater Elevation (Feet AMSL)
Approximate Groundwater Flow Direction (October 2006)
Monitoring Well
Piezometer
Staff Gauge/Other Structure
Roads
Railroads
Wetland Area
SurfaceWater_Lines
Surface Water
Topographic Contours \(2-Ft Interval)
Buildings
Other Structures
Area of Investigation
Yard 520 Type III (South) Area
Figure 6
Groundwater Contour Map - October 2006
Pines Area of Investigation
PORTER COUNTY, INDIANA
N
0 250 500 1,000 1,500 2,000 Feet
Source:
Flown on March 13, 2004
Basemap prepared by Air Maps Inc.
AECOM

FIGURE 7
CONSERVATIVE MAXIMUM AVERAGE PERCENT CCBs AT GROUND SURFACE - RESIDENTIAL EXPOSURE AREAS
ALTERNATIVES SCREENING TEHCNICAL MEMORANDUM




Legend
5 Location of suspected CCB thickness greater than 4 feet and at all wells where encountered; thickness in feet
Boron Concentrations in Groundwater
All results <=0.73 mg/l
At least one result >0.73 AND <=7.3 mg/l
At least one result >7.3 mg/l
Field Verified Suspected CCB Locations (see Figure 3-19)
Inferred Suspected CCB Locations (see Figure 3-19)
Approximate areas of suspected CCBs extending substantially beyond roadways
Area of Investigation
Yard 520
Roads
Railroads
Wetland Area
Surface Water
Topographic Contours (2-Ft Interval)
Buildings
Figure 8
Migration of CCB-Derived Constituents to Groundwater Pines Area of Investigation
PORTER COUNTY, INDIANA
N
0 250 500 1,000 1,500 Feet
Source:
Flown on March 13, 2004
Basemap prepared by Air Maps Inc.
AECOM
BEVERLY DR
US HIGHWAY 12
LAKE SHORE COUNTY ROAD
INDIANA DUNES NATIONAL LAKESHORE (IDNL)
WEST DUNES HIGHWAY
EAST JOHNS AVENUE
CENTRAL AVE
CAROLINA ST
CALIFORNIA ST
KINTZELE DITCH
HICKORY AVE
BROWN DITCH
MAINE AVE
ARDENDALE AVE
US HIGHWAY 20
COUNTY LINE RD
EARL RD
YARD 520
MW120
MW119
MW123
MW103
MW104
MW101
MW102
MW116
MW124
PW003
MW105
TW-18D
TW-18S
TW-16S
TW-16D
TW-15D
TW-15S
TW-12
TW-10
MW-6
MW-8
MW-3
MW122
PW006
PW007
PW008
MW115
MW114
PW010
MW113
PW009
PW013
PW012
MW117
6
TP033
>5
MW111
5
PW005
MW121
MW110
MW106
1.5
GP017
6
MW107
2
TP026
>4.5
TP027
>7
TP020
>6
TP016
5
GP016
6
TP015
>5.5
MW108
1.5
MW109
5
IDEM
>8
IDEM
11-12


INDIANA DUNES NATIONAL LAKESHORE (IDNL)
WEST DUNES HIGHWAY
US HIGHWAY 12
LAKE SHORE COUNTY ROAD
CENTRAL A
KINTZELE DITCH
BROWN DITCH
US HIGHWAY 20
ARDENDALE AVE
COUNTY LINE RD
0.73
2.0
7.3
Legend
Boron Isoconcentration Lines at 0.73,2.0 and 7.3 mg/l
Municipal Water Service Area
Area of Investigation
Roads
Railroads
Wetland Area
Surface Water
Topographic Contours (2-Ft Interval)
Buildings
Notes:
Boron isoconcentration lines estimated from all available RI information including: Boron concentrations in groundwater (Figure 4-1) and surface water (Figure 4-22), groundwater hydraulic gradients (Figures 3-5 to 3-9), the presence of larger areas of suspected CCBs (Figure 3-19), and information compiled on Figure 4-18.
Isoconcentration lines chosen are human health risk-based comparison level (0.730 mg/l) and tap water RSL (7.3 mg/l).
Figure 9
Estimated Boron in Groundwater above Comparison Levels
Pines Area of Investigation
PORTER COUNTY, INDIANA
N
0 250 500 1,000 Feet
Source:
Flown on March 13, 2004
Basemap prepared by Air Maps Inc.
AECOM



Note:
The outline shown on this map is an interpretation based on all the information collected during the RI, such as groundwater and surface water sampling, extent of suspected CCBs, and hydraulic gradients.

As discussed in the HHRA, groundwater in well MW104 appears primarily impacted by septic systems.

MW120 is a background well, so the arsenic represents a background condition

Figure 10
RI Groundwater and Private Well Water Sample Locations Drinking Water Cumulative Risk Screening Results Pines Area of Investigation

PORTER COUNTY, INDIANA

Source:
Flown on March 13, 2004
Basemap prepared by Air Maps Inc.

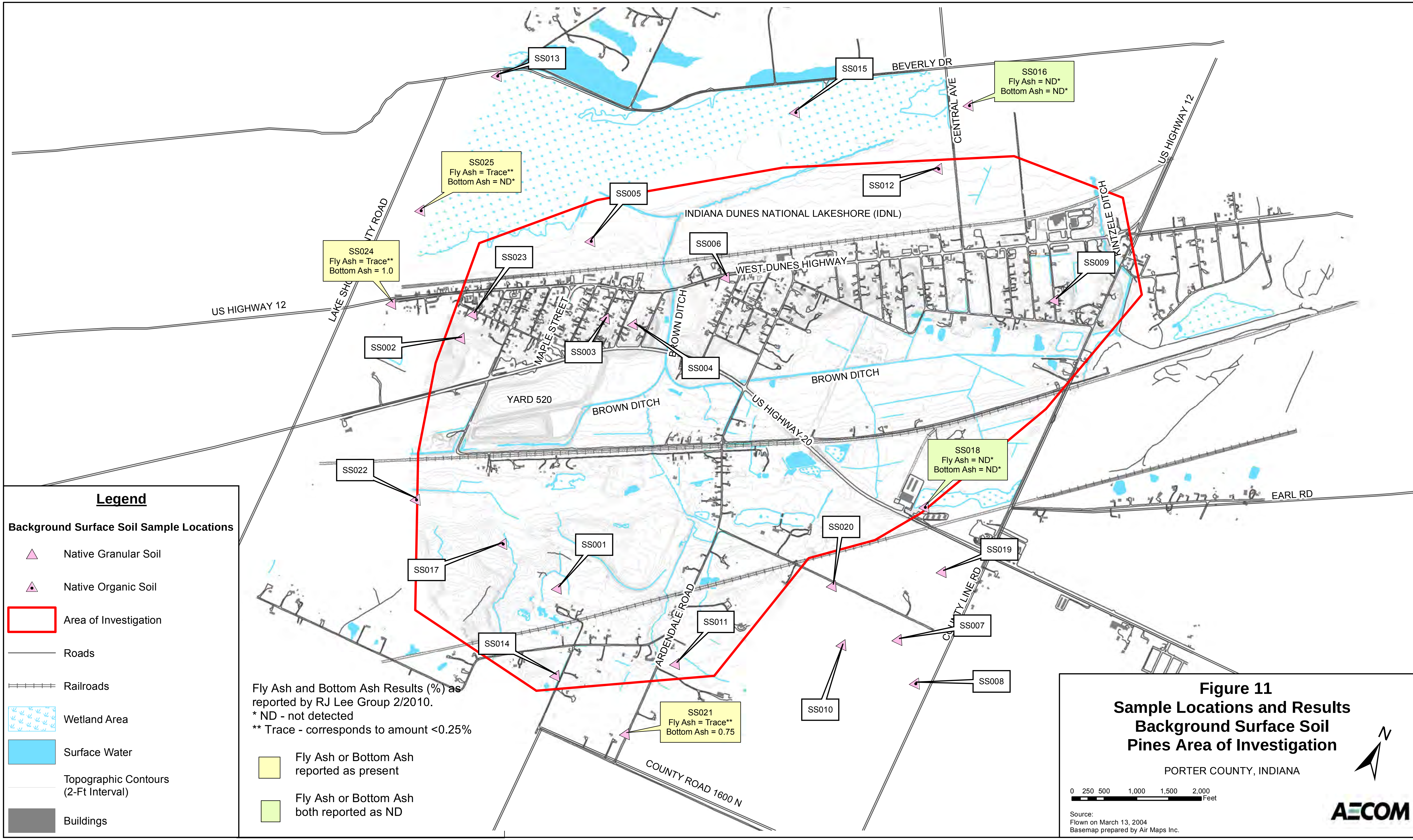


Figure 11
Sample Locations and Results
Background Surface Soil
Pines Area of Investigation

Appendix A1

Response to USEPA comments dated April 18, 2012 regarding the Remedial Action Objectives Technical Memorandum

Enclosure

TECHNICAL REVIEW COMMENTS ON TECHNICAL MEMORANDUM, REMEDIAL ACTION OBJECTIVES, PINES AREA OF INVESTIGATION, AOC II

The "Technical Memorandum, Remedial Action Objectives, Pines Area of Investigation, AOC II" (Remedial Action Objectives [RAO] technical memorandum), was prepared by AECOM for Brown, Inc., Ddalt Corp., Bulk Transport Corporation, and Northern Indiana Public Service Company (NIPSCO), and is dated January 2012. The RAO technical memorandum was reviewed for conformance with the Remedial Investigation (RI) dated March 2010, and the Human Health Risk Assessment (HHRA) and Screening Level Ecological Risk Assessment (SLERA), both dated December 2011, and relevant EPA and Indiana Department of Environmental Management (IDEM) risk assessment guidance.

General and specific technical review comments are presented below. The specific comments refer to particular sections, pages, paragraphs, appendixes, figures, and tables in the RAO technical memorandum. References cited in the technical review comments are listed immediately following the specific comments.

GENERAL COMMENTS

1. The RAO technical memorandum was submitted to the EPA before EPA's technical review comments on the HHRA and SERA, both dated December 2011, and including specific modifications, had been prepared. The Alternatives Screening Technical Memorandum must be drafted to incorporate these comments and the modifications to both the HHRA and SERA. Issues related to several of the more significant technical review comments on the HHRA and SERA are expressed below in the general and specific comments.

   Response: Acknowledged.

2. As discussed in Section 2.2.1, a visual inspection program was developed and conducted as part of the RI. The HHRA used the results of this program to quantify the maximum average percent of coal combustion by-products (CCB) at the ground surface as 27 percent. However, the results of the visual inspection program have not been verified through laboratory analysis. The uncertainty associated with the use of HHRA risks and hazards using the 27 percent CCB scenario based on unverified visual inspection program results should be identified and discussed.

   Response: A discussion of the uncertainty associated with the visual inspection program has been included in Section 2.2.1 of the Alternatives Screening Memorandum, with supporting information provided in Attachment A of Alternatives Screening Memorandum. See also response to Specific Comments #2 below.

3. A variety of editorial errors, omissions, and inconsistencies were identified. Examples (but not a thorough and complete list) are listed below. The RAO technical memorandum should be carefully reviewed and all editorial errors, omissions, and inconsistencies corrected.

   Response: Acknowledged.

- Acronyms and abbreviations (A&A): (1) Several A&A were not spelled out at the location of their first use. Examples include: mg/L, ERA, RI, and UMTRCA. All A&A should be spelled out at the location of their first use. (2) Several standard chemical abbreviations were used in the text, but not included on the list on page vii. Examples include: S, Si, HCO_3, Cl, and NO_3. All standard chemical abbreviations used in the RAO technical memorandum should be identified.

  Response: Acknowledged.

- The third paragraph of Section 3.2.2 includes discussion of the terms "criterion maximum concentration:" and "secondary maximum concentration" with their corresponding acronyms. The acronyms for both of these terms are missing the closing parentheses.

  Response: The parenthetical phrase for each of these included both the acronym <u>and</u> a definition of the term. The parentheses have been used correctly. No revision is needed.

SPECIFIC COMMENTS

1. **<u>Section 2.2.1, Page 2-3, Paragraphs 3 and 4</u>.** Section 2.2.1 summarizes the results of the CCB visual inspections. As noted in General Comment 2, the visual inspection program results have not been verified through laboratory analysis and, therefore, are associated with uncertainty and must be interpreted cautiously.

   Also, the text states that "there have been no reports of areas of CCBs being present within the Area of Investigation that have not already been identified, and the identified areas coincide with historical information discussed in the Site Management Strategy document." This statement is not accurate. It would be more accurate to state that "it is clear, based on historical evidence and visual inspection, that CCBs were used as fill only in a subset of the Area of Investigation."

   Response: The requested change has been made.

   As discussed in Section 3.1.1 of the HHRA, CCBs (in the form of fly ash and bottom ash) were identified in 3 of 5 background soil samples (60 percent) in portions of the Area of Investigation where CCBs had not been known to be deposited. It is expected that the presence of CCBs in these non-depositional areas is the result of secondary fate-and-transport processes such as fugitive dust emissions and secondary deposition, surface water runoff, and erosion. However, the concentration of CCBs is expected to be lower in any areas of secondary deposition or transport. Although CCBs were used as fill in only a subset of the Area of Investigation, CCBs may have been transported elsewhere in the Area of Investigation through secondary fate-and-transport processes.

   Response: No change has been requested here. However, it should be noted that of the five background samples analyzed for CCBs, one sample was reported to contain 1% CCBs and two samples were reported to contain <1% CCBs. These trace levels should be noted to provide the reader of Pines Area of Investigation documents with an informed perspective. Such as, "CCBs (in the form of fly ash and/or bottom ash) were identified in 3 of 5 background soil samples (60 percent of the samples evaluated) at concentrations of $\leq$1% at locations in the Area of Investigation where CCBs had not been known to be deposited."

2. **<u>Section 2.2.2, Page 2-4, Paragraph 1</u>.** Section 2.2.2 discusses the chemistry of background soil. The detection of CCBs (in the form of fly ash and bottom ash) at concentrations of up to 1 percent in 60 percent of the background soil samples tested should be discussed. The presence of even low levels of CCBs in the majority of the background soil samples that were analyzed for the presence of CCBs limits the usefulness of the existing background soil data set. Therefore, the results of any comparisons of chemical of potential concern- (COPC) specific concentrations and associated risks and hazards to site-related COPC-specific concentrations, risks, and hazards must be interpreted cautiously. Finally, additional background soil samples may be collected in subsequent project phases if necessary to support the remedial design/remedial action. After verification through laboratory analysis of the absence of CCBs, background soil COPC-specific concentrations, risks, and hazards may be recalculated. This possibility and the use of these updated background soil results in revising current RAOs and for creating new RAOs as necessary should be discussed.

   Response: We agree that the detection of CCBs (in the form of fly ash and bottom ash) in background soil samples tested should be discussed; however, we do not agree that the identification of trace CCBs causes the results to be of limited usefulness. A quantitative analysis of the CCB and background data has been included in Attachment B of the Alternatives Screening Memorandum. This evaluation shows that that the potential risk and hazard estimates are only very slightly lower than those estimated in the HHRA. Therefore, the inclusion of background samples that may contain up to 1% CCBs has virtually no impact on the comparison between potential risks associated with suspected CCBs and background soils.

3. **<u>Section 2.2.4 Page 2-5, Paragraph 5 and Figure 10</u>.** The text states that "CCB-derived constituents in groundwater do not extend northward into IDNL [Indiana Dunes National Lakeshore] at levels of significance." However, neither this RAO technical memorandum nor the RI report includes information supporting this statement. In addition, as Figure 10 shows, the current outline of the suspected groundwater plume has moved away from the source area at Yard 520, which suggests that the plume may continue to move offsite.

   Response: The sentence referred to in this comment was taken verbatim from the USEPA-approved RI Report. The RI includes data demonstrating that CCB-related constituents in groundwater did not extend into INDL during the RI. In addition, the Respondents are conducting on-going sampling of five monitoring wells located at or beyond the downgradient limits of CCB-related constituents in groundwater and upgradient from IDNL. Sampling of these wells shows that CCB-related constituents in groundwater do not currently extend to INDL. The mere presence of CCB-related constituents in groundwater outside Yard 520 is not a sufficient basis to suggest the likelihood of future migration northward.

4. **<u>Section 2.2.4 Page 2-6, Paragraph 8</u>.** The text states that "overall, there has been no significant change in groundwater levels or hydraulic gradients since completion of the RI field work." However the RAO technical memorandum only includes one figure showing the boron concentrations in wells located to the north of Yard 520 and the technical memorandum does not include post-RI data for wells located on Yard 520 or in the easterly direction from Yard 520. Post-RI groundwater COPC concentrations in wells located on Yard 520 and downgradient of Yard 520 and other fill areas, should be discussed. In addition, an additional RAO to address the spread of CCBs-impacted groundwater beyond Yard 520 and other fill areas should be added.

Response: The approved RI/FS Workplan included four groundwater sampling events that were conducted in 2006-2007. Since that time, the Respondents have continued sampling a subset of monitoring wells. This sampling effort has been termed "Post-RI" sampling. The sampling results from these Post-RI events were included in the final RI Report. The data collected through May 2011 were posted by EPA on the EPA website for the Pines Area of Investigation [http://www.epa.gov/region5/cleanup/pines/index.htm]. A copy of all the Post-RI sampling results, including the most recent sampling in April 2012, has been included in the Alternatives Screening Memorandum in Attachment C.

In addition, groundwater is monitored around Yard 520 on a semi-annual basis in accordance with Post-Closure requirements. Semi-annual monitoring reports can be obtained from IDEM. For reference, the most recent Yard 520 groundwater monitoring report is included here as Attachment B.

5. **<u>Section 2.3.3, Page 2-10, Paragraph 3</u>.** Section 2.3.3 summarizes the exposure assessment from the HHRA. The first bulleted item summarizes exposure pathways and assumptions for residential receptors. The last sentence of the paragraph states that the drinking-water pathway is the only potentially complete exposure pathway for receptors using the groundwater as a drinking-water source. This statement is not correct. Residential receptors engaged in recreational activities may be directly exposed to groundwater through seeps and sediments, and indirectly through exposure to surface water that has been impacted by groundwater or seeps. These additional potential direct and indirect groundwater exposure pathways, including any post-RI groundwater, surface water, seep and sediment data should be discussed.

   Response: Note that the last sentence of the referenced bullet reads: "The drinking water pathway is only potentially complete for those residents who use groundwater from the surficial aquifer as a drinking water source." It does not say that that is the only exposure pathway for constituents in groundwater. The conceptual site models included in the HHRA and the SERA showed the connection between groundwater and surface water/sediment. The RI and the risk assessments also acknowledge that the source of constituents in Brown Ditch is likely due to groundwater discharge. However, as sediment and surface water were analyzed and evaluated separately from groundwater, the data have been distinguished in the report. An evaluation of the potential risks associated with contact with surface water and sediment using Post-RI data has been conducted and is included in Attachment D of the Alternatives Screening Memorandum. An evaluation of the potential risks associated with contact with seep water has been conducted and is included in Attachment E of the revised memorandum. The Post-RI groundwater data are presented in Appendix C; a review of the groundwater data for boron indicate that all concentrations are below the current Regional Screening Level for tap water of 3100 μg/L.

6. **<u>Section 2.3.4, Pages 2-11 and 2-12</u>.** Section 2.3.4 introduces the risk characterization results from the HHRA. Paragraph two of this section identifies a constituent of concern (COC) as any COPC "that causes an exceedance of the 10-4 risk level for a particular receptor." In support of this position, Section 2.3.4 presents two quotes from the EPA's guidance document entitled "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions" (EPA 1991). This guidance document also states the following: "A risk manager may also decide that a baseline risk level less than 1E-04 is unacceptable due to site-specific reasons and that remedial action is warranted." This part of the guidance must also be considered because the Area of Investigation encompasses a residential area. Also, the EPA typically identifies the low end of EPA's risk range of 1E-06 to 1E-04 (EPA 1990) as a "point of departure." In other words, all COPCs with risks greater than or equal to 1E-06 (as well as non-carcinogenic hazards greater than 1 as stated in Section 2.3.4) should be

identified as COCs. This will allow risk managers to judge whether risks greater than or equal to 1E-06, but less than or equal to 1E-04, require remediation.

<u>Response:</u> Acknowledged.

7. **<u>Section 2.3.4, Page 2-13, Paragraphs 4 and 5</u>.** The subject paragraphs present the comparison of risks for background and CCB scenarios. Two significant problems were identified in this discussion. The first relates to the limited usefulness of any comparisons of background soil results to CCB scenarios, given the identification of CCBs in 60 percent of the background soil samples tested for CCBs. The uncertainties associated with the results of any such comparison should be discussed.

   Second, any comparison between a single data set (based on CCB samples from the municipal water service extension [MWSE]) and background results does not account for the variability within individual properties from the Area of Investigation. In other words, the simplified comparison of MWSE CCB results to background soil results does not exclude the possibility of elevated concentrations of CCB-related COPCs at individual properties. If any of the individual properties contain CCB-related COPC concentrations greater than background and associated with risks greater than or equal to 1E-06 and/or hazards greater than 1 (COCs), then an RAO will be required to address these risks and hazards.

   Response: The uncertainties associated with the CCB visual inspection program and the use of the background data for risk assessment purposes has been addressed above in the responses to Specific Comments #1 and #2. As discussed in the EPA-approved HHRA Report (Section 6.5.3.2), historical information indicates that the suspected CCBs present in residential lots are expected to be the same as CCBs encountered in rights-of-way (and sampled under the MWSE SAP). Thus the MWSE sample results provide a robust data set that is a reasonably conservative representation of suspected CCBs within the Area of Investigation. USEPA guidance requires the use of the 95% upper confidence limit (UCL) on the arithmetic mean as the exposure point concentration, or EPC, for risk assessment purposes. This statistical methodology acknowledges that there is a 5% chance that specific sample locations may have a concentration greater than the EPC. The statistical calculation of the 95% UCL, using USEPA's ProUCL software, takes into account the variability in the data when calculating this value. Where the data are more variable, the 95% UCL will be higher. While there may be some locations where a single analytical result may be higher than the 95% UCL, that single result is unlikely to represent the average concentration across a given property. As described in USEPA guidance, the reasonable maximum exposure (RME) scenario is not meant to define the absolute maximum of all exposure inputs, but rather reasonable upper bounds. A discussion of the conservatism used to calculate the maximum average value of 27% CCBs on residential properties is provided in Section 2.3.4 of the memo.

   Also, we do not agree with the characterization of the MWSE CCB dataset and the background soil dataset as simply a "single dataset." There are 25 sample results in the background soil dataset and 34 sample results in the MWSE dataset – both are robust datasets.

8. **<u>Section 2.3.5, Page 2-16, Paragraphs 1 and 2</u>.** Section 2.3.5 presents a summary of the conclusions of the HHRA. As discussed in Specific Comment 6, a COPC associated with a risk greater than or equal to 1E-06 and/or a hazard greater than 1 for any receptor should be defined as a COC and risks and hazards for all COCs should be discussed.

   Response: Acknowledged.

9. **<u>Section 2.4.4. Page 2-20, Paragraphs 2 and 3</u>.** Section 2.4.4 presents a summary of the conclusions of the SERA. As discussed in General Comment 1, these conclusions must address the comments provided by the EPA for the SERA.

   Response: Acknowledged.

10. **<u>Section 3.2.1, Pages 3-2 to 3-4, Paragraph 1</u>.** Section 3.2.1 does not include the Regional Screening Level (RSL) tap-water values as criteria to be considered (TBC). Criteria TBC are not potential applicable or relevant and appropriate requirements (ARARs) because they are not enforceable; however, it may be necessary to consult TBCs when defining remediation goals if ARARs do not exist for potential COPCs. The RSL tap-water values as criteria TBC should be included, along with the ARARs, which are based on Maximum Contaminant Levels (MCLs).

    Response: RSL tap-water values have been added as TBC criteria to this Section.

11. **<u>Section 3.2.3, Page 3-5, Paragraph 1</u>.** Section 3.2.3 states that the State of Indiana's Risk Integrated System of Closure (RISC) program "was ultimately not deemed an ARAR." It is recognized that RISC provides soil screening levels and "is considered by Indiana as a non-rule policy document, which means it does not have the full force and effect of the law"; however, it is recommended that RISC be included as a TBC.

    Response: Indiana's RISC program has been added as TBC criteria to this Section.

12. **<u>Section 3.3, Page 3-5, Paragraph 1</u>.** Preliminary location-specific ARARs should be identified.

    Response: Location-specific ARARs have been included in the Alternatives Screening Memorandum, which includes the revised RAO Technical Memorandum.

13. **<u>Section 4.0, Pages 4-1 and 4-2</u>.** Section 4.0 presents the RAOs proposed for the Area of Investigation. RAOs 1 and 2 propose preventing future use of groundwater for drinking water in the wetland areas in the vicinity of MW111 and MW122 and in the MWSE area, respectively. RAOs should also include the reduction of the potential sources of groundwater contamination, which include the areas of significant CCB deposition. RAO 1 should be modified as follows: "<u>Reduce the volume, toxicity, and/or mobility of CCBs in the areas represented by those wells identified with risks greater than or equal to 1E-06, including, but not limited to MW6, MW8, TW15D, MW104, MW111, and MW122, and hazards greater than 1 including, but not limited to MW3, MW6, MW8, TW10, TW12, TW15D, TW16D, TW18D, MW106, MW111, and MW122</u>."

    Response: EPA's revised RAO 1 appears to address the potential migration of CCB- related COCs from CCBs to groundwater in the Area of Investigation. Further, via this RAO and other RAOs suggested by EPA, EPA must consider guidance provided in "Role of the Baseline Risk Assessment in Superfund Remedy Selection Documents" (PSWER 9355.0-30, April 1991), thus inclusion of the risk management range (carcinogenic risks within 1E-06 to 1E-04) is more appropriate. Finally, RAO 1 must also consider background concentrations, established for the Pines Area of Investigation in the RI. RAO 1 has thus been revised to: <u>"Reduce the volume, toxicity, and/or mobility of CCB- and site-related COCs in the areas represented by those wells identified with COCs greater than background levels that are unaffected by site-related contamination and with risks within and/or</u>

above USEPA's target risk range of 1E-06 to 1E-04 and a target endpoint specific hazard index of 1, including, but not limited to MW-3, MW-6, MW-8, MW-10, TW-12, TW-15D, TW-16D, TW-18D, MW111, and MW122."

Also, as noted in Specific Comment 7, the HHRA considered a single data set as representative of the CCB scenario. As presented in Table 1 of the RAO technical memorandum, the risks associated with the CCB scenario appear to be similar to those posed by background. (Note: this conclusion must be interpreted cautiously due to the limited usefulness of the current background soil data set). Nonetheless, use of a single data set does not consider the potential variability of risks and hazards at individual properties. In other words, the simplified comparison of MWSE CCB results to background soil results does not exclude the possibility of elevated concentrations of CCB-related COPCs at individual properties. If any of the individual properties contain CCB-related COPC concentrations associated with risks greater than or equal to 1E-06 and/or hazards greater than 1 (COCs), then one or more RAOs will be required to address these risks and hazards. Therefore, the following RAO should be included as RAO 4. "Reduce or eliminate exposure to contamination at any of the individual properties that are determined to contain COPC concentrations greater than background and associated with risks greater than or equal to 1E-06 and/or hazards greater than 1."

Response: The use of the background dataset and its impact on the HHRA results are discussed in the response to Specific Comments #1 and #2. RAO 4 has been revised to acknowledge the USEPA target risk range, as discussed above: Reduce or eliminate potential exposure to CCB- and site-related COC concentrations at or near the ground surface greater than background levels that are unaffected by site-related contamination and associated with risks within and/or above USEPA's target risk range of 1E-06 to 1E-04 and a target endpoint specific hazard index of 1.

In addition, RAO 2 should be modified to prohibit the installation of any private wells that may result in unacceptable risk, irrespective of their use or location. RAO 2 should be modified as follows: "Prevent the installation of private wells and any use of groundwater in all areas where COPC concentrations are associated with risks greater than or equal to 1E-06 and/or hazards greater than 1."

Response: The HHRA for the Pines Area of Investigation showed that the only potential risks identified above regulatory targets for any of the receptor scenarios and exposure pathways evaluated was for the drinking water pathway; thus, this is the only use of groundwater that should be restricted. The revised RAO is as follows: Prevent the installation of private wells and use of groundwater for drinking in all areas where COC concentrations are greater than background levels that are unaffected by site-related contamination and are associated with risks within and/or above USEPA's target risk range of 1E-06 to 1E-04 and a target endpoint specific hazard index of 1.

RAO 3 should be modified to include detected groundwater concentrations that may pose a risk to any ecological or human receptors. The SERA identified potential risks in both surface water and sediments because the media concentrations for a number of constituents were found to be above those screening values based on the "no observed adverse effect level" and at or slightly above the screening values based on "lowest observed adverse effect level." Because of this situation and the concern for the potential for groundwater contaminants to pose a continuing contaminant source to both sediments and surface water, the RAO 3 should be modified as follows: "Provide for the long-term protection of the

Indiana Dunes National Lakeshore from groundwater, surface water and sediment contamination originating in Area of Investigation."

Response: Although the SERA identified COC concentrations above screening levels, the conclusion of the SERA was that no significant potential for ecological risk to aquatic and terrestrial receptors is occurring within the Area of Investigation.
The revised RAO is as follows: Provide for the long-term protection of the Indiana Dunes National Lakeshore from groundwater, surface water and sediment contamination originating from CCBs and site-related COCs in the Area of Investigation.

Groundwater in the surficial aquifer is highly vulnerable to contamination, as it is unconfined at or near the surface and is made up of materials having high transmissivities. The groundwater also discharges either directly or indirectly through drainage ditches to the Great Marsh and/or other wetlands managed for ecological purposes on federal lands. Specifically, such discharges occur within the Indiana Dunes National Lakeshore managed by the National Park Service. Therefore, the groundwater in the surficial aquifer is ecologically vital. The aquifer is also the same aquifer that is currently used as a drinking water source by nearby residents. The following RAOs should be included. RAO 5 should be included as follows: "Restore ground water to achieve and maintain Federal and State drinking water standards, protective levels (corresponding to a 1x10-6 cancer risk for carcinogens or a hazard index of 1 for non-carcinogens) and ambient water quality criteria, whichever are more stringent, within a time frame that is reasonable considering practicable response action alternatives." RAO 6 should be included as follows: "Monitor ground water upgradient and downgradient of the Yard 520 and other disposal/fill areas to ensure that the potential beneficial uses of ground water (drinking and discharge to surface water) are met by achieving and maintaining Federal and State drinking water standards, protective levels (corresponding to a 1x10-6 cancer risk for carcinogens or a hazard index of 1 for non-carcinogens) and ambient water quality criteria, whichever are more stringent, at the waste management boundary of Yard 520 and other disposal/fill areas."

Response: RAO 5 has been revised to read: Restore groundwater to achieve and maintain ARARs, including federal and state drinking water standards and ambient water quality standards, protective levels (corresponding to risks within and/or above USEPA's target risk range of 1E-06 to 1E-04 and a target endpoint specific hazard index of 1) and/or background levels that are unaffected by site-related contamination for CCB-related constituents within a timeframe that is reasonable considering practicable response action alternatives.

Regarding RAO 6, Yard 520 is regulated, closed and maintained under IDEM Regulations; further discussion of groundwater monitoring relative to Yard 520 will not be included in this FS. RAO 6 has been revised to read: Monitor groundwater upgradient and downgradient of CCB fill areas to demonstrate remedial progress and determine when potential beneficial uses of groundwater (drinking and discharge to surface water) are met (i.e., achieving and maintaining ARARs including federal and state drinking water standards and ambient water quality standards, protective levels (corresponding to risks within and/or above USEPA's target risk range of 1E-06 to 1E-04 and a target endpoint specific hazard index of 1) and/or background levels that are unaffected by site-related contamination for CCB-related constituents).

14. **Table 1.** Table 1 presents a summary of potential human health risks for non-drinking-water pathways under reasonable maximum exposure (RME) scenarios. Several comments are presented below.

- The table notes state, “Blue text indicates a total potential risk value above background.” Foremost, this statement doesn’t reflect the uncertainty associated with any comparison to a background soil data set that has been compromised due to the presence of low concentrations of CCBs in over half of the samples tested. Second, while the overall risks and hazards associated with the CCB data set do not appear to exceed background results, the use of a single data set to represent multiple individual properties does not account for the variability of risks and hazards for resident receptors at individual properties. Consistent with Specific Comment 7, Table 1 should include a note that discusses the potential for individual properties to contain CCB-related COPC concentrations associated with risks greater than or equal to 1E-06 and/or hazards greater than 1. Finally, background risks and hazards are highlighted in blue font. None of the background results should be in blue font because background results cannot by definition exceed themselves.

  Response: The change to the blue font will be made. Please see the responses to Specific Comments #1 and #2 above regarding background. Please also see response to Specific Comment #7 above. The issues related to the conservatism in the calculation of the maximum average 27% CCB scenario is presented in Section 2.2.1, and the assumptions surrounding the use of the 95% UCL as the EPC are discussed in Section 2.3.3.

  For the resident receptor, suspected CCBs and Brown Ditch, 100 percent CCB scenario, the hazard based on the target endpoint of hair should be 1.78 (thallium and vanadium), not 1.65 (thallium) – this comment applies also to Pond 1 and Pond 2 rows on Table 1.

  Response: The total hair HI for suspected CCBs is 1.78 as noted in the comment, and is 1.9 for all exposure pathways for Brown Ditch, 1.78 for Pond 1, and 1.8 for Pond 2. However, thallium is the constituent driving the exceedance with an HI of 1.65 for suspected CCBs. The vanadium HI is well below one (0.132) and does not contribute to the exceedance of one for the target endpoint.

- Table 1 should identify the HHRA table from which the receptor-specific risks and hazards were extracted. For example, the risks and hazards for the recreational child were extracted from HHRA Tables 6-9 and 6-10. Adding another column would work well.

  Response: Table 1 has been revised to include the HHRA table references.

15. **<u>Table 2</u>.** Table 2 presents a summary of potential groundwater risks. Several comments are presented below.

- Carcinogenic risks are presented in multiple columns. Each carcinogenic risk should appear in only one column (the one associated with the highest risk level). For example, for the “Groundwater – Yard 520” results, MW6 with arsenic as a COC is identified under all three columns. MW6 should be removed from the 10-5 and 10-6 columns.

  Response: The requested change has been made.

- For Groundwater – Yard 520 results, the non-carcinogenic hazard for MW6 should identify arsenic (As) in addition to boron (B) as a hazard driver. Also, the table should clarify whether well TW10 is the same as MW10.

  Response: The requested change has been made and TW-10, which is the same as MW-10, has been changed to MW-10.

- For Groundwater – served by MWSE (excluding Yard 520), the non-carcinogenic hazards should be revised to add TW15D with arsenic as a hazard driver.

  Response: The requested change has been made.

- For Groundwater – outside MWSE, the non-carcinogenic hazard for MW111 should be revised to add thallium (Tl) as a risk driver. Similarly, the non-carcinogenic hazard for MW122 should be revised to add arsenic (As) as a hazard driver.

  Response: The requested changes have been made.

- The table should identify the HHRA table from which the receptor-specific risks and hazards were extracted. For example, the risks and hazards for the recreational child were extracted from HHRA Tables 6-9 and 6-10. Adding another column would work well.

  Response: Table 2 has been revised to include the HHRA table references.

16. **<u>Figure 9</u>.** This figure presents the boron concentrations in groundwater; however, the figure does not include the dates when the samples were collected or whether the results depict the maximum, average, or minimum concentrations detected. The figure should reflect the sample date(s) for each location and whether the results represent the maximum, average, minimum, or other concentrations detected.

    Response: Figure 9 is identical to Figure 4-19 of the RI Report. The distribution of boron in groundwater that is shown on the map represents an interpretation based on all available data, such as: all four RI groundwater sampling events; the results of the CCB visual inspections; the results of surface water sampling; understanding of hydraulic gradients and groundwater flow directions. This is documented in the Notes box in the lower left corner of the figure.

17. **<u>Figure 10</u>.** This figure shows a small area of cumulative risk exceeding 1E-04 around MW111. The area of cumulative risk near MW111 is shown as only extending around the well location and not beyond. The RI notes that this well is located in an area of known CCBs, which were measured to be 5 feet thick within MW111. To be conservative, the figure should show the area of cumulative risk extending halfway to the next area with risk less than 1E-06, or the area should encompass the "approximate area of suspected CCB[s]" as shown on Figure 8.

    Response: A revised map is provided.

REFERENCES

U.S. Environmental Protection Agency (EPA). 1990. "National Oil and Hazardous Substances Pollution Contingency Plan." *Federal Register*. Volume 55, Number 46. April 9.

EPA. 1991. "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions." Office of Solid Waste and Emergency Response (OSWER) Directive 9355.0-30. April.

Appendix A2

Response to USEPA comments dated August 31, 2012 regarding the Alternatives Screening Technical Memorandum

TECHNICAL REVIEW COMMENTS ON TECHNICAL MEMORANDUM, ALTERNATIVES SCREENING, PINES AREA OF INVESTIGATION, AOC II

General and specific technical review comments are presented below. The Specific Comments refer to particular sections, pages, paragraphs, appendixes, figures, and tables in the AS Technical Memorandum. References cited in the technical review comments are listed immediately following the Specific Comments.

GENERAL COMMENTS

1. The AS Technical Memorandum is intended to incorporate responses to comments on the RAO Technical Memorandum and technical review comments on the HHRA and SLERA, both dated December 2011.

   Response: Acknowledged.

2. The AS Technical Memorandum indicates that there is site-related risk above 1E-6 and above background levels, but does not propose any active remediation alternatives to address these risks. A full range of alternatives, providing various remedial approaches and various levels of risk reduction, is not included, as required by EPA's Remedial Investigation/Feasibility Study (RI/FS) Guidance (Section 4.1.3). Effective alternatives need to be considered to address the real risk drivers at the site. Some alternatives may not be selected because of site-specific reasons, but they need to be available for consideration.

   Response: Acknowledged.

3. The use of Municipal Water Service Extension (MWSE) data as a surrogate for residential yards was acceptable for conducting a HHRA. However, because the results show that risk is within the risk management range, albeit close to background, additional data are needed with respect to individual residential yards. There is a real possibility that the variability within a specific yard is such that the risk to exposure from that yard is sufficient for remedial action to be warranted. Additional sampling of residential yards is needed to provide information so that an informed decision can be made by risk managers in regard to meeting RAOs.

   Response: Property-specific sampling will be considered pending the outcome of the additional background sampling and analysis. See also response to specific comment #30.

4. No active remedial approach to address groundwater contamination is proposed. As discussed in the AS Technical Memorandum, the Indiana Groundwater Quality standards have been determined to be "applicable" to the site. 327 IAC 2-11-5 (2) states that:

   > Groundwater shall be maintained and protected to ensure that a contaminant concentration attributable to human activity does not increase in a drinking water well.

   This regulation, along with EPA's stated policy of returning usable groundwaters to their beneficial uses wherever practical, indicates that alternatives to address groundwater contamination (including, but not limited to, boron), must be prepared and included in the Feasibility Study.

   Response: The draft Alternatives Screening Technical Memorandum included Monitored Natural Attenuation as an in-situ approach to groundwater restoration. The revised Memorandum includes four active and two passive groundwater alternatives, as detailed in the response to Specific Comment # 27.

5. Given that a removal action (installation of the municipal water service extension) has already been implemented, the inclusion of a "No Further Action" alternative instead of the "No Action" alternative is technically acceptable as an alternative to consider.

   Response: Acknowledged.

6. The document mentions several times that Yard 520 is regulated by IDEM; this is cited as a reason for not proceeding with further actions at Yard 520. While it is true that Yard 520 is regulated by IDEM, Yard 520 is part of the Pines Site and therefore CERCLA may be used as the regulatory authority to conduct further actions at Yard 520 as part of a remedial action at the Town of Pines site. Any data collected pursuant to IDEM's requirements should also be provided to EPA as it is relevant to further action within the area of investigation.

   Response: These statements are intended to reference that Yard 520 is in compliance with the applicable Indiana Regulations and with the terms of its Post Closure Permits issued under those Regulations. Further actions at Yard 520 under CERCLA would need to be warranted under the National Contingency Plan. Copies of Yard 520 monitoring reports from 2009 to the present are being sent to USEPA under separate cover.

SPECIFIC COMMENTS

1. **Section 2.2.1, Page 2-6, Paragraphs 1 and 2.** Section 2.2.1 summarizes the coal combustion by-products (CCB) visual inspections. Paragraph 1 refers to the maximum 27 percent CCBs developed in the HHRA. It is important to clarify that, while the maximum 27 percent CCB value was developed using a conservative methodology, it is based only on surface soil (0 to 6 inches below ground surface [bgs]) samples. There is no information as to the percentage of CCBs in subsurface soil at residential properties in the Pines Area of Investigation. Section 2.2.1 should be revised to clarify this point.

   Response: The phrase "in surficial soils" has been added in several locations within the text of Section 2.2.1 to clarify that the visual inspections were completed on surficial soils. Also, the following text was added to the next-to-last paragraph in this section:

   > *"While there is no information as to the percent CCBs in subsurface soils, the majority of potential residential exposure is to surface soils."*

   As discussed in Paragraph 2, the exposure point concentrations (EPC) used in the HHRA were calculated as the 95 percent upper confidence limit (UCL) of the arithmetic mean using the U.S. Environmental Protection Agency's (EPA) recommended software (ProUCL). The text also notes that the 95 UCL accounts for variability in the data (in this case, samples from the MWSE). The text notes that, while there may be individual locations within particular yards that exceed the calculated 95 UCL, the single point is not representative of the average concentration across a particular property. However, at a given property, one or more elevated sampling results, coupled with a higher variability than found in the MWSE samples, may result in a property-specific 95 UCL that is higher than the MWSE-based 95 UCL used in the HHRA. Therefore, it will be necessary to conduct some degree of property-specific sampling for use in comparing to an updated soil background data set (see Section 6.2.4) and to calculate property-specific risks and hazards. See also General Comment 3. Section 2.2.1 should be revised accordingly.

   Response: While we disagree with this conclusion, the following sentence has been added to the last paragraph of this section:

"However, it is possible that at a given property there could be higher concentrations and/or higher variability than found in the MWSE data set."

2. **<u>Section 2.2.2, Pages 2-6 and 2-7, Paragraphs 4 and 0</u>.** Section 2.2.2 discusses the chemistry of background soil. The discussion reports that five of the 25 background[1] soil samples (20 percent) were tested for the presence of CCBs. The results of this testing showed that 60 percent of the tested samples contained CCBs2. One sample contained 1 percent CCBs, and 2 samples contained <1 percent CCBs. The subsequent assessment of the significance of CCBs on background soil chemistry assumes there is an upper bound of 1 percent CCB content for the entire population of CCB-impacted background samples. In effect, the assessment assumes that one of the five samples analyzed identified the most heavily impacted sample of the entire population. The discussion provides no rationale supporting this assumption. Subtracting the contribution of 1 percent CCBs from the background data set is not appropriate unless it can be shown that 1 percent CCBs actually represents the highest concentration of CCBs in background soil samples *and* the composition of the CCBs present in the background soil samples has been demonstrated. Please identify each of the samples analyzed, the locations from which they were collected, and the amount of CCBs present in each sample on a map that also displays all of the background soil samples. The concentration of CCB constituents should be plotted against the percent CCB in each sample to visually assess the potential impact of CCB contamination on the background data set.

   Response: A new Figure 11 has been added that shows the location of the background samples and the results of the particulate matter analysis conducted to determine if CCBs are present in the five samples submitted for analysis.

3. **<u>Section 2.2.4, Page 2-9, Paragraph 1</u>.** Section 2.2.4 summarizes the chemistry of groundwater in the Area of Investigation. The text identifies the purpose of post-remedial investigation (RI) groundwater sampling as "to identify whether CCB-derived constituents in groundwater are migrating further northward (that is, in a new direction)." This phraseology is confusing. The direction being evaluated is not new. CCB-derived constituents have already been shown to have migrated from sources of CCBs (for example, Yard 520) north toward the Indiana Dunes National Lakeshore (IDNL). The additional sampling is designed to evaluate whether contaminants are migrating "<u>further</u> northward" (emphasis added). Section 2.2.4 should be revised to remove or revise text related to "a new direction."

   Response: Text was edited as requested.

4. **<u>Section 2.3.3, Page 2-14, Paragraph 3</u>.** Section 2.3.3 summarizes the exposure assessment section of the HHRA. Paragraph 3 discusses the calculation of the EPCs from MWSE data to represent residential exposure conditions in the Area of Investigation. The discussion is very similar to the discussion presented in Section 2.2.1. Therefore, Specific Comment 1 regarding Section 2.2.1 also applies to Section 2.3.3. Section 2.3.3 should be revised accordingly.

   Response: The following sentence has been added to the last paragraph of this section:

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1 The background samples were identified as unimpacted based upon an initial criterion of no CCBs observed upon visual inspection.

2 The distribution of CCBs among the five samples may be important to consider as well. Soil samples (2) with granular texture universally showed CCBs may present. The remaining three samples, in only one of which CCBs may be present, were described as "peat" and contained 70 to 96 percent organic material. The limited data suggest that the significance of the data relative to soil type is yet to be established.

"However, it is possible that at a given property there could be higher concentrations and/or higher variability than found in the MWSE data set."

5. **<u>Section 2.3.4.1, Page 2-16, Paragraph 5</u>.** Section 2.3.4.1 summarizes the results of the chemical and radiological risk assessment for non-drinking water exposure pathways. The subject paragraph relates to a summary of constituent-specific risk results. The text states, "In addition, carcinogenic regulatory targets were not exceeded for any of the RME or CTE site-specific 27% CCB scenarios, sediment or surface water scenarios, or construction workers contact with groundwater under RME or CTE scenarios." As shown in Table 1 from the memorandum, risks for the recreational child and recreational fisher exceed 1E-06 (the low end of EPA's risk range). As mentioned in part of previous EPA comments, EPA's guidance document entitled "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions" states, "A risk manager may also decide that a baseline risk level less than 1E-04 is unacceptable due to site-specific reasons and that remedial action is warranted." EPA typically identifies the low end of EPA's risk range of 1E-06 to 1E-04 (EPA 1990) as a "point of departure." In other words, site-specific risks should be compared to the full risk range of 1E-06 to 1E-04. Therefore, Section 2.3.4.1 should be revised to clearly identify that the risks associated with the child recreationalist and recreational fisher exceed 1E-06.

   It should also be noted that Table 1 presents the risks and hazards for the recreational child and recreational fisher under the "Hypothetical Screening Level 100 % Scenario." This is misleading. The dual paradigm of 100 percent and 27 percent CCBs applies only to residential soil exposures. Table 1 and related text should be revised to clearly state that the surface water, sediment, and fish ingestion exposures assumed for the recreational child and recreational fisher stand alone and are unrelated to the CCB-specific 27 and 100 percent exposure paradigm.

   Response: The text under "Summary of Constituent Specific Risk Results" in Section 2.4.3.1 has been revised to identify the potential risks for the recreational fisher and the recreational child that exceed 1E-6.

   Regarding Table 1, the 27%CCB scenario is applicable only to residential and outdoor worker potential exposures to CCBs. Construction workers were assumed to contact 100% CCBs, and recreational receptors were assumed to breathe dusts derived from 100% CCBs. Surface water, sediment, and fish tissue exposures for both recreational and residential receptors are unrelated to the %CCB exposure scenario. Therefore, construction worker and recreational receptor potential risks and hazards are presented under the 100% CCB scenario. Potential risks and hazards for residential and outdoor worker receptors are presented under both scenarios. However, it should be noted that since potential risks and hazards for the residential receptor for surface water, sediment, and fish tissue are unrelated to the %CCB exposure scenario, they are the same under both the 27% and the 100% scenarios, such that only the potential risks from CCBs varies between the scenarios.

   A footnote to this effect has been added to Table 1, and the first paragraph in Section 2.4.3.1 has been revised to include this information. The phrase "*for the residential and outdoor worker CCB exposure scenarios*" was added to two sentences in Section 2.2.1 that reference the site-specific 27% CCB scenario.

6. **<u>Section 2.3.4.1, Page 2-17, Paragraph 2</u>.** This portion of Section 2.3.4.1 discusses the use of the MWSE sample results to represent potential residential exposures. EPA does not disagree that the "MWSE sample results provide a robust data set that is a reasonably conservative representation of suspected CCBs within the Area of Investigation." As such, the MWSE sample data and related HHRA results provide a starting point for risk management decisions. The MWSE-based residential risk results show residential chemical and radiological risks for the Area of Investigation that are within EPA's risk management

range. While the MWSE sample results may provide a good overall representation of residential exposure conditions across the Area of Investigation, as discussed in Specific Comment 1, in relation to Section 2.2.1, it is necessary to conduct some degree of residential property-specific sampling corresponding to the range of property-specific risks and hazards in the Area of Investigation; there may be property-specific risks and hazards that exceed those based on MWSE samples. The need for residential property-specific sampling is also discussed in General Comment 3. Section 2.3.4.1 should be revised to discuss the need for property-specific samples to verify and build on the MWSE-based HHRA results.

Response: The following text has been added to the last paragraph of this section:

"As such, the MWSE sample data and related HHRA results provide a starting point for risk management decisions and provide a good overall representation of residential exposure conditions across the Area of Investigation. "

See also response to specific comment #30.

7. **<u>Section 2.3.4.2, Page 2-18, Paragraphs 3 and 4</u>.** Section 2.3.4.2 summarizes the results of the drinking water risk assessment. The text concludes the "Evaluation of CCB-derived Constituents" with the following statement:

> Thus, this evaluation of the drinking water pathway indicates that CCB-derived constituents in groundwater used as drinking water outside of the immediate vicinity of Yard 520, whether within or outside of the municipal water service extension area would not be expected to pose a health risk to residents.

This conclusion is incomplete. The text implies, but does not clearly state, that, if future residents were to use groundwater from the area represented by monitoring wells MW111 and MW122, these residents would incur risks greater than 1E-06. Section 2.3.4.2 should be revised to clearly describe the potential for unacceptable risks to residents if groundwater represented by monitoring wells MW111 and MW122 were used as a drinking water supply.

Response: The last three sentences of the first paragraph in this section have been revised as follows:

"Therefore, the drinking water pathway for exposure to CCB-derived constituents in the area outside the municipal water service area is likely incomplete, with the exception of MW111 and MW122, where total potential risks exceeded 10^{-4} and the total potential hazard index exceeded one. These two wells are located in wetland areas that are unlikely to be developed, though such development in the future cannot be precluded. However, MW111 and MW122 are in areas that could easily be provided municipal water if developed in the future to avoid the potentially unacceptable risks identified in the HHRA."

8. **<u>Section 2.3.5, Page 2-19, Paragraphs 5 and 6</u>.** Section 2.3.5 summarizes the conclusions of the HHRA. The text states:

> Based on the results of the HHRA as summarized above, risks above regulatory targets were not identified for any of the receptor scenarios evaluated in the risk assessment with the exception of monitoring wells in the immediate vicinity of Yard 520 and in limited wetland areas.

As noted in Specific Comment 4 regarding Section 2.3.4.1, risk managers may require remediation of risks greater than 1E-06, the low end of EPA's risk range. In other words, the regulatory target risk is not limited to 1E-04, but encompasses a range from 1E-06 to 1E-04. Therefore, Section 2.3.5 (and similar, related sections throughout the AS Technical Memorandum) should be revised to clearly state that risks greater than 1E-06 were identified for the recreational child and the recreational fisher related to exposures in Brown Ditch and Ponds 1 and 2.

Response: The first paragraph of Section 2.3.5 has been revised to state that potential risks for the recreational child and the recreational fisher exceed 1E-6. The second paragraph of Section 2.3.5 and the third paragraph of Section 4.0 were revised to remove the reference to "regulatory targets" with more the more specific 1E-6 and hazard index of one, and to identify the two wells with potential risks in the 1E-5 range.

9. **Section 2.4.3.1, Page 2-22, Paragraph 2.** The text states that "Findings from the percent fines normalization background evaluation also indicated that risks to wildlife receptors foraging within the Brown Ditch system and the pond exposure area due to several COPECs are expected to be similar to background risks." As has been noted in previous EPA comments on the risk assessment, the Agency does not agree with this statement and it should be removed.

   Response: These sentences have been deleted from the text.

10. **Section 4.0, Page 4-2, Paragraph 6, RAO 4.** Based on EPA comments on the RAO Technical Memorandum, it appears that language is missing from RAO 4. As specified in Appendix A of the AS Technical Memorandum, RAO 4 should read as follows: "Reduce or eliminate potential exposure to CCB- and site-related COC concentrations at ***or near*** the ground surface greater than background levels that are unaffected by site-related contamination and associated with risks within and/or above USEPA's target range of 1E-06 to 1E-04 and a target endpoint specific hazard index of 1." Please note that the bold and italicized language was omitted on Page 4-2 and should be included.

    Response: Text was edited as requested.

11. **Section 5.2, Page 5-1, Paragraph 4.** Section 5.2 discusses areas within the Pines Area of Investigation to which General Response Actions apply. The first sentence in this paragraph states, "Potential risks within the USEPA risk range of 10^{-4} to 10^{-6} were identified for suspected CCBs." The discussion does not clearly identify two important facts: (1) samples for chemical and radiological analysis have not been collected from individual residential properties and (2) soil samples (possibly including some percentage of CCBs) have not been collected across much of the Pines Area of Investigation (see the note on Figure 4). Section 5.2 must be revised to clearly make both of these points.

    Response: The following sentence has been added to the last paragraph of this section:

    "Soil samples for chemical and radiological analysis were not collected from individual residential properties, and soil samples (possibly including some percentage of CCBs) have not been collected across much of the Pines Area of Investigation."

12. **Table 6; Page 1, Land Use Control Row.** Table 6 identifies potential remedial technologies. Under Institutional Controls, Deed restrictions, Groundwater ordinance(s), and "Alternative Controls / Measures" are listed, but no examples of the "alternative controls" are cited. Examples of the alternative controls should be provided, along with a description as to how they will be equivalent to the deed restrictions and groundwater ordinance(s).

    Response: The following sentences have been added to the description of the Land Use Controls:

    "Alternate institutional controls could be implemented to support groundwater use restrictions or other activities. These may consist of: a periodic well survey to ensure that no new wells have

been installed; and/or periodic review with the Town and/or County to review if any well installation permits have been issued for the area."

13. **<u>Table 7, page 1 and 2, row discussing land use controls</u>.** With respect to the discussion under the "Implementability and/or Cost" column, it is stated that it may not be possible to identify owners of the many small undeveloped lots. This is incorrect; ownership information is readily available from Porter County; both in person and via the county's website.

    Response: The text was edited as follows: "….*it may be challenging to contact and obtain timely approval from the owners of the many small, undeveloped lots*." Please note that we are well aware that ownership information is available from Porter County, and we relied on it extensively in the RI portion of the project to obtain access agreements. However, using this information was challenging and required many visits to the assessor's offices to determine ownership of specific properties. Our assessment of the level of difficulty with this task is based on our direct experience in using the available resources, and is not due to a lack of familiarity with those resources. EPA staff were involved with these efforts during the RI and understood the impact that the lack of clear and straightforward ownership information had on the RI schedule.

14. **<u>Table 7, page 1 and 2, row discussing land-use controls</u>.** Given the active community involvement at this site, the implementability of either deed restrictions or a groundwater use ordinance, particularly at the town level, would likely be difficult.

    Response: While it may be difficult, it certainly is not precluded, and we would hope that all parties are open to considering a full range of remedial options. The following bullet was added to the implementability column under the Land Use Controls row:

    Given the active community involvement, implementing a deed restriction or groundwater use ordinance may be challenging.

15. **<u>Table 7, page 2, last row, Containment: Cap (soil/groundwater)</u>.** Under the "Implementability and/or Cost" column, it states that "Yard 520 is capped and so this remedial action has already been implemented." Although Yard 520 has been capped, seeps were observed in 2010 and 2011 by both IDEM and EPA. The current effectiveness of the cap on Yard 520 should be demonstrated in order to claim that "This cap addresses the source of potential groundwater impacts observed at wells….," as stated in the "Effectiveness" column. Additionally, the "Effectiveness" column states that the cap over Yard 520 is effective at addressing the contamination at various wells and then goes on to state that a cap would not be effective in other portions of the Area of Investigation. If a cap is working at Yard 520, a cap may be applicable to some other portions within the Area of Investigation. At this stage, capping should be retained as a remedial alternative.

    Response: The discussion of effectiveness for the Engineered Cap has been edited as follows:

    An engineered cap is currently in place over Yard 520. Closure plans for Yard 520 were prepared and implemented under IDEM regulatory authority. This cap reduces the source of potential groundwater impacts observed at wells MW-3, MW-6, MW-8, MW 10, TW-12, TW-15D, TW-16D, TW-18D, and MW122."

    Capping may be appropriate for areas outside of Yard 520, although USEPA does not contemplate this option in their proposed revised remedial alternatives for the FS (as presented in Specific Comment # 27). However, capping will be retained as a potential option in the event that areas are identified where CCB-related constituents are present at the ground surface at concentrations greater than background and associated with risks within and/or above USEPA's target risk range of 1E-06 to 1E-04 and a target endpoint specific hazard index of 1.

16. **<u>Table 7, Page 3, bottom row, Containment: passive (groundwater)</u>.** In the discussion under the "Effectiveness" column, it is mentioned that Yard 520 is regulated by IDEM and thus passive containment options are not currently within the regulators' scope to address groundwater downgradient of Yard 520. While it is true that Yard 520 is regulated by IDEM, this does not prohibit actions being taken at Yard 520 under CERCLA. This section should be revised to indicate that CERCLA authority could be used to address issues at Yard 520.

Response: The following text has been added as the first bullet under the effectiveness column for Containment: passive (groundwater):

> *Yard 520 is currently regulated under IDEM and is in compliance with the applicable Indiana Regulations and with the terms of its Post Closure Permits issued under those Regulations. Further actions at Yard 520 under CERCLA would need to be warranted under the National Contingency Plan.*

17. **<u>Table 7, Page 3, bottom row, Containment: passive (groundwater)</u>.** Under the "Screening Status" column, containment is eliminated on the basis of the groundwater plume being stable, based on 6 years of data. The table should be revised to indicate that containment of groundwater at or near Yard 520 may be effective in reducing the extent of the plume.

Response: The second bullet under the effectiveness column for Containment: passive (groundwater) has been changed as follows:

> *Six years of available data indicate that the current extent of CCB-related COCs in groundwater is contained. However, the containment option may be effective at reducing possible future migration and, potentially, reducing the extent of the impacted area.*

Further, the screening status column for this row has been revised as shown in Table 7.

18. **<u>Table 7, Page 4, bottom row, Containment: Active (groundwater)</u>.** In the discussion under the "Effectiveness" column, mention is made that Yard 520 is regulated by IDEM and so passive containment options are not currently within regulators' scope to address groundwater downgradient of Yard 520. While it is true that Yard 520 is regulated by IDEM, this does not prohibit actions being taken at Yard 520 under CERCLA. This section should be revised to indicate that, although Yard 520 is presently regulated by IDEM, CERCLA authority is also used to address issues at Yard 520.

Response: The following text has been added as the first bullet under the effectiveness column for Containment: active (groundwater):

> *Yard 520 is currently regulated under IDEM and is in compliance with the applicable Indiana Regulations and with the terms of its Post Closure Permits issued under those Regulations. Further actions at Yard 520 under CERCLA would need to be warranted under the National Contingency Plan.*

19. **<u>Table 7, Page 4, bottom row, screening status column</u>.** The elimination of groundwater containment at this time is premature. Eliminating groundwater extraction/treatment, particularly in the more limited form of containment, eliminates an active remedial alternative, and does not provide a range of alternatives which meet various levels of risk reduction to choose from. At least two active groundwater treatment technologies, such as pump and treat, in-situ treatment, hydraulic containment, or some other active remedy should

be retained and incorporated into an alternative which would provide active treatment of groundwater.

Response: Groundwater containment has been retained for evaluation in the Feasibility Study.

20. **Table 7, Page 5, first row, Effectiveness column, first bullet.** Under the "Effectiveness" column, it is stated that Yard 520 is regulated under IDEM and therefore *ex-situ* treatment options are not currently within the regulatory scope. While it is true that Yard 520 is regulated by IDEM, this does not prohibit action being taken at Yard 520 under CERCLA. This section should be revised to indicate that, although Yard 520 is presently regulated by IDEM, CERCLA authority is used to address issues at Yard 520.

    Response: The following text has been added as the first bullet under the effectiveness column for Containment: active (groundwater):

    > *Yard 520 is currently regulated under IDEM and is in compliance with the applicable Indiana Regulations and with the terms of its Post Closure Permits issued under those Regulations. Further actions at Yard 520 under CERCLA would need to be warranted under the National Contingency Plan.*

21. **Table 7, Page 5, first row, Effectiveness column, second and third bullets.** Groundwater extraction has been used to successfully reduce groundwater concentrations throughout a large area, as well as for containment. Extraction of source water, particularly from the area immediately surrounding Yard 520, could be very effective at reducing groundwater concentrations of COCs off the Yard 520 property. Long-term clean-up of groundwater may require a different technology. This portion of the table should be revised to reflect that groundwater extraction can be effective at achieving the RAOs. The point about groundwater treatment for boron being complex and more expensive than treatment for other parameters is noted.

    Response: The second bullet has been revised as follows:

    > *Groundwater extraction of source water, particularly from the area immediately surrounding Yard 520 could be effective at reducing groundwater concentrations off the Yard 520 property*.

    The following sentence was added to the end of the third bullet:

    > *Therefore, long-term remedial options may require an alternate technology.*

22. **Table 7, Page 5, second row, Effectiveness column, first bullet.** Under the "Effectiveness" column, it is stated that Yard 520 is regulated under IDEM and so *ex-situ* treatment options are not currently within the regulatory scope. While it is true that Yard 520 is regulated by IDEM, this does not prohibit action being taken at Yard 520 under CERCLA. This section should be revised to indicate that CERCLA authority is also used to address issues at Yard 520.

    Response: The following text has been added as the first bullet under the effectiveness column for Containment: active (groundwater):

    > *Yard 520 is currently regulated under IDEM and is in compliance with the applicable Indiana Regulations and with the terms of its Post Closure Permits issued under those Regulations. Further actions at Yard 520 under CERCLA would need to be warranted under the National Contingency Plan.*

23. **Table 7, Page 5, second row, Implementability column, first bullet.** The excavation of all CCBs outside of Yard 520 is dismissed as "infeasible" without any further justification, such as an approximate estimate of quantity. Removal of the roads may not be very practical, but an institutional control requiring the removal of CCBs beneath roads or parts of roads (such as utility trenches) and replacement with clean fill as part of maintenance activities is something that should be considered. Furthermore, it is feasible that excavation of selected areas outside of Yard 520 could be performed. These selected areas could include (1) residential yards; (2) school / church / playground yards; and/or (3) selected excavation in areas where migration of CCBs is highly likely. There is precedent for these types of actions being taken at other CERCLA sites. Excavation from residential yards and their equivalent is a common approach at residential lead and arsenic sites. This section of the table should be revised to reflect that excavation is feasible for the reasons cited above.

Response: While there is certainly precedence for removal actions on residential properties at other CERCLA sites, it is important to also consider the risk assessment context of such sites and the target risk levels used to make those specific remedial decisions. The following sentence was added to the first bullet:

> *Removal at selective locations with CCBs is potentially feasible (e.g., residential yards, schools, churches, and playgrounds), where it is demonstrated to be warranted.*

A new second bullet as added as follows:

> *An option associated with institutional controls would be to require the removal of CCBs beneath roads or portions of roads (i.e., utility trenches) and replacement with clean fill as part of maintenance activities.*

24. **Table 7, page 6, first row, Effectiveness column, first bullet.** This bullet is incorrect. Excavation is an effective way to permanently remove CCBs and eliminate potential mobilization of CCB-related COCs to groundwater. If the CCBs are no longer present, the future mobilization of CCB-related COCs is prevented. Excavated material would have to be managed, but on-site treatment would not require formal permitting, which is not required under CERCLA, but would have to meet the technical requirements of such a permit. Disposal of CCBs in an existing, off-site permitted facility would be another option. This bullet should be revised to reflect the comments above.

Response: While the Respondents agree that excavation is an effective way to permanently remove CCBs and eliminate potential mobilization of CCB-related COCs to groundwater, and the text will be edited as requested, we do not agree that large-scale excavation of all CCBs within the Area of Investigation (e.g., beneath all Town roads, within Yard 520, etc.) is feasible, which was the point of this bullet statement. Before excavation is implemented in a specific location, it must be demonstrated that the specific excavation will materially achieve the relevant RAOs.

25. **Table 7, Page 6, first row, Effectiveness column, second bullet.** Obtaining backfill which contains constituent levels below risk levels should not be difficult. There are several aggregate suppliers listed in Michigan City who are capable of providing suitable material for backfilling beneath roads and along utility lines. It is agreed that a source of suitable backfill material would need to be located for backfilling in lawn areas, but no supporting information is provided to support the claim that obtaining suitable backfill is extremely difficult. A quick Internet search turned up several Michigan City and vicinity suppliers of topsoil in bulk.

Response: We do not disagree that there are vendors of fill or topsoil in the vicinity of the Area of Investigation. However, before excavation is selected as a remedy at a particular location, it must be demonstrated that the concentrations of risk drivers (e.g., arsenic) in the fill material are materially/significantly lower than either background or the materials that are to be excavated. The bullet (which is now bullet #3) has been revised as follows:

- *Obtaining backfill that contains constituents at levels below background levels, below risk targets, or below the levels in material it is replacing, may be challenging.*

26. **Table 7, page 6, second row, effectiveness column, first bullet.** Two comments. First, in the FS Report, more information will need to be provided to demonstrate that monitored natural attenuation (MNA) is occurring, and is therefore a viable alternative. Several guidance documents are available which provide guidance on the information needed to demonstrate that MNA can be a viable alternative at sites involving metals.

    Response: A detailed analysis of MNA will be conducted in the FS, in accordance with USEPA guidance.

    Second, this bullet states that concentrations of CCB-related constituents have been decreasing; this appears to contradict information provided earlier in Table 7, where it is stated that that COCs are not migrating further downgradient and the extent is not expanding, which describes a stable plume. This discrepancy should be resolved.

    Response: USEPA and its agency partners have expressed concern about migration of the plume farther north towards IDNL (see Specific Comment #3). The statement that the plume is not expanding and not migrating to the north was intended to provide information on this specific issue. However, there are wells (MW101, MW105) where boron concentrations have decreased from their maximum concentrations measured several years ago. A formal evaluation of whether these data suggest plume shrinkage has not been completed. Therefore, it is consistent and conservative to note that the plume is not expanding. The bullet has been revised as follows:

    MNA would be effective in reducing mobility of many CCB-derived COCs in groundwater within the existing plume areas. The CCBs present in the Area of Investigation are a source of CCB-derived COCs, but have been shown with 6 years of existing data to migrate a limited distance in the aquifer. Natural attenuation mechanisms are present within the aquifer and have been shown to be reducing the concentrations of many CCB-related constituents downgradient from areas of CCB fill.

27. **Section 6.2.** Section 6.2 assembles remedial alternatives from the remedial technologies screened on Table 7. One set of alternatives, consisting of a combination of soil and groundwater, has been assembled. Notably, soil is addressed in only two alternatives: Alternative 1 – No Further Action and Alternative 4 – Additional Data Evaluation and Review. Furthermore, the alternatives presented do not provide a range of options in terms of risk reduction from which to select. Given the nature of the site, with COCs present in primarily two media (groundwater and soils / sediment), the development of two sets of alternatives—one for groundwater and one for soil—is appropriate. Where one alternative for one medium is dependent on one or more alternatives from the other medium being chosen, that should be noted in the description of the alternatives. Based on the comments above, an example of the assembled alternatives which should be provided is outlined below:

    Groundwater Alternatives

    Alternative GW 1: No Further Action
    This alternative is self-explanatory. No further action, beyond the existing MWSE, would be performed.

    Alternative GW 2: Land-Use Controls
    This alternative would be similar to the existing Alternative 2.

    Alternative GW 3: Monitored Natural Attenuation
    This alternative would be similar to the existing Alternative 3.

Alternative GW4: Active Groundwater Treatment
This would be a new alternative, and would propose some sort of active groundwater treatment as a way of restoring the aquifer to beneficial use. It would provide a cost, risk reduction, and time-frame comparison with other groundwater alternatives.
Alternative GW4: Passive Groundwater Treatment
This would be a new alternative, and would propose some sort of passive groundwater treatment as a way of restoring the aquifer to beneficial use. It would provide a cost, risk reduction, and time-frame comparison with other groundwater alternatives.

Soil Alternatives:
Alternative Soil 1: No Action
This alternative is self-explanatory. No action (or no further action, if the closure of Yard 520 is considered an action) would be performed.
Alternative Soil 2: Land-Use Controls
This alternative would apply land-use controls, if appropriate, to control the risk from exposure to surficial soils.
Alternative Soil 3: Limited Residential Area and Sensitive Area Surficial CCB Removal
This alternative would involve the sampling and removal / replacement (as necessary) of surficial soils in residential and sensitive locations, such as, but not limited to parks, schools, playgrounds, day-care facilities, and ecologically sensitive locations.
Alternative Soil 4: Extensive Surficial CCB Removal
This alternative would involve the complete removal of surficial CCBs from within the investigation area to achieve 10^{-6} risk level or background. This alternative would remove surficial CCBs not just from the existing residential and sensitive locations (as in Alternative Soil 3), but also from vacant and undeveloped land within the Area of Investigation. Additional sub-alternatives, providing varying degrees of risk reduction (i.e., down to 1E-5 or 1E-6 or background excess cancer risk) could be provided.

A revised list of alternatives should be provided. The revised list should contain a full range of alternatives as outlined above.

Response: The following list of remedial alternatives has been presented in Section 6, and will be carried forward to the FS:

Groundwater Alternatives
GW Alternative 1: No Further Action
GW Alternative 2: Land-Use Controls
GW Alternative 3: Monitored Natural Attenuation
GW Alternative 4: Active Groundwater Treatment
GW Alternative 5: Passive Groundwater Treatment

Soil Alternatives:
Soil Alternative 1: No Further Action
Soil Alternative 2: Land-Use Controls
Soil Alternative 3: Limited Residential Area and Sensitive Area Surficial CCB Removal
Soil Alternative 4: Extensive Surficial CCB Removal

28. **Section 6.2.2 Alternative 2: Land Use Control and Table 9, Page 1, first row.** Section 6.2.2 and the corresponding row of Table 9 discuss Alternative 2: Land-Use Controls. The text essentially refers to Table 9 for details on the alternative. The deed restrictions and groundwater use ordinance, while potentially effective, may be difficult to implement, given the high level of interest and apparent distrust by the community. As a result, the ability to actually implement this alternative, particularly within the time frame specified, is questionable. Table 9 should be revised with a more realistic time frame.

Response: In Table 9A, the text under "logistical challenges" for "Land Use Controls" was edited as follows:

- *Groundwater Ordinance: May be difficult to implement and will be pending Town/County government approval of the Groundwater Ordinance language.*
- *Deed Restriction(other areas): Discussions and approvals of the language of the deed restriction will be required from owners of private property, which may be difficult. In addition, if restrictions were to be considered over a relatively large area, based on experience during the RI for access agreements, it may be difficult to identify owners of the many small, undeveloped lots.*

The timeframe for implementation was changed to 1-2 years after USEPA approval.

Alternative land-use controls, in the form of periodic well survey and review of local permits, is not a control. These can be used to verify that the ordinance and/or deed restrictions are being properly enforced, but in and of themselves do not represent a land-use control. Table 9 should be revised to eliminate a periodic well survey and permit review as land use controls; they may be retained as mechanisms to verify the enforcement of land use controls.

Response: The referenced text was deleted as requested.

As discussed in Specific Comment 13, county records are readily available to identify the owner(s) of property, so the identification of such owners should not be difficult. Contacting the owner(s) and obtaining their approval for any land-use control on their property is another matter, and may be difficult.

Response: Refer to response to Specific Comment #13.

29. **Section 6.2.3 Alternative 3: Monitored Natural Attenuation and Table 7, page 1, bottom row.** Section 6.2.3 and the corresponding row of Table 9 discuss Alternative 3: Monitored Natural Attenuation. In the FS Report, additional data will need to be provided to demonstrate that MNA is a viable option at this site. Several guidance documents are available which discuss the type of information needed for such a demonstration.

    Response: A detailed analysis of MNA will be conducted in the FS, in accordance with USEPA guidance.

30. **Section 6.2.4 Alternative 4 and Additional Data Evaluation and Review and Table 9, page 2 first row.** Section 6.2.4 and the corresponding row of Table 9 discuss the need for obtaining additional data and evaluating it before providing an analysis of potential options regarding CCB-related COCs at the ground surface. At this time, based on the data, this seems appropriate. This further supports the idea presented above of separating alternatives into two groups (groundwater and surficial soils / sediments). Given additional data are going to be collected, some data from the surface soils of private properties, particularly those of residences or other sensitive receptors, should be strongly considered.

    As discussed in Specific Comment 5 related to Section 2.3.4.1, the MWSE sample data and related HHRA results provide a starting point for risk management decisions. The MWSE-based residential risk results show residential chemical and radiological risks for the Area of Investigation that are within EPA's risk range. While the MWSE sample results may provide a good overall representation of residential exposure conditions across the Area of Investigation, as discussed in General Comment 3 and Specific Comment 1, related to Section 2.2.1, it is necessary to conduct some degree of residential property-specific sampling to evaluate the range of property-specific risks and hazards in the Area of Investigation; there may be property-specific risks and hazards that are in excess of those based on MWSE samples. Property-specific results, will be needed to evaluate whether and at which specific residential properties, RAO 4 has been achieved. Therefore, Section 6.2.4 must be revised to explain the need for some degree of property-specific sampling for use in comparing to an updated soil background data set (see Section 6.2.4) and to calculate property-specific risks and hazards in order to evaluate whether and, if so, at which residential properties across the Pines Area of Investigation RAO 4 has been achieved. Relevant sampling guidance can be found in the Superfund Residential Lead Contaminated Sites Handbook.

The collection of additional data can be completed simultaneously with the writing of the FS report by making an assumption that some percentage of residences/private properties will have CCB COC-related risk above background and the 1E-6 threshold. Alternatively, the proposed alternatives in the FS report could be drafted to include pre-design sampling to characterize the actual properties requiring remediation.

Response: The Respondents will submit a work plan for the collection and evaluation by particulate matter analysis followed by analytical chemistry, where warranted, of additional background soil samples. This work will involve renewal or acquisition of new access agreements, sample collection, laboratory analysis, data validation, and data evaluation, perhaps in an iterative manner, until sufficient numbers of background samples free of bottom ash and/or fly ash can be obtained, per USEPA's direction (see Specific Comment #2 above). The background level is critical to determining both potential risk above background and locations where surface soil concentrations may be above background and/or within or above the target risk range of 1E-06 to 1E-04 and or an endpoint specific hazard index of 1. This information is critical to designing a Feasibility Study for soils that is meaningful. Therefore, we agree with the suggestion that a Groundwater Feasibility Study and a Soils Feasibility Study be conducted on separate schedules. Under this proposal, the Respondents will submit a Groundwater Feasibility Study under the timeframe provided in the comment letter and the Order, and the Soils Feasibility Study will be completed on a separate track, making sure to acquire the data needed to make meaningful decisions for the soils remedy.

REFERENCES

U.S. Environmental Protection Agency (EPA). 1988. "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA". October.

EPA. 1990. "National Oil and Hazardous Substances Pollution Contingency Plan." *Federal Register*. Volume 55, Number 46. April 9.

EPA. 1991. "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions." Office of Solid Waste and Emergency Response (OSWER) Directive 9355.0-30. April.

EPA. 2003. "Superfund Lead-Contaminated Residential Sites Handbook. August.

Appendix B

Supporting Documentation for Chapter 2.0

Attachment A – Visual Inspection Uncertainty Evaluation

Uncertainty Evaluation for 27% CCB Estimate

Some uncertainty is introduced into the human health risk assessment (HHRA) estimates from the use of the 27% coal combustion-by product (CCB) value derived from the visual inspections due to the nature of the evaluation (i.e., visual inspection versus laboratory testing). However, the samples were classified by trained staff and the classifications were conducted to over-estimate rather than under-estimate the CCB content. The visual inspections identified many properties where CCBs were not present. Only properties where CCBs were present were included in the calculation of the maximum average percent CCBs. Also, for the exposure calculations, each inspection location was assumed to contain the maximum percent in the range of suspected CCBs in which it was classified, that is:

- all inspection locations in the 0-25% range were assumed to consist of 25% CCBs,
- all inspection locations in the 26-50% range were assumed to consist of 50% CCBs,
- all inspection locations in the 51-75% range were assumed to consist of 75% CCBs,
- all surface inspection locations that did not have a percent of suspected CCBs assigned were assumed to consist of 25% CCBs.

Note that there were no inspection locations identified in the 75-100% CCB range.

By including only those properties where the presence of suspected CCBs was identified, and by assuming each inspection location contained the maximum percent of CCBs within the classification range, uncertainty was highly biased toward estimating a high average percent of CCBs. Therefore, the method used to calculate the percent of CCBs present on each property was very conservative. In addition, the maximum calculated value (27%), was then used in evaluating potential risk.

As noted previously, the maximum percent CCBs at any property was calculated as 27%. The 27% value was used in the HHRA under the site-specific scenario. The percent CCBs at the 43 properties surveyed ranged from a low of less than 1% to the maximum 27%. The following summary statistics and median and percentile values were calculated, as well as the 95% upper confidence limit (UCL). The UCL was calculated using ProUCL Version 4.1.01 (Attachment 1 provides the ProUCL output):

Summary statistics	
Minimum average percent CCBs	0.18%
Maximum average percent CCBs	27.38%
Mean average percent CCBs	6.77%
Percentiles of the average percent CCBs	
10th	1.16%
50th (median)	5.19%
90th	14.45%
UCL of average percent CCBs	
95% Approximate Gamma UCL	8.61%

As shown above, the estimates of the upper bound of the percent suspected CCBs are much lower than the maximum average percent used in the HHRA. The 95% UCL calculated by ProUCL is 8.6%, almost one quarter the value used in the HHRA. The 90th percentile of 14.5% is almost half of the value used in the HHRA. The use of the maximum average percent CCBs to represent all the properties reduces the uncertainty, because the majority of properties contain a much lower percent CCBs.

To further demonstrate the conservative nature of the approach, an alternative estimate of the percent of CCBs present in each exposure area was derived, in which the midpoint of the percent within each classification range, instead of the maximum was used, that is:

- all inspection locations in the 0-25% range were assumed to consist of 12.5% CCBs,
- all inspection locations in the 26-50% range were assumed to consist of 37.5% CCBs,
- all inspection locations in the 51-75% range were assumed to consist of 62.5% CCBs,
- all inspection surface locations that did not have a percent of suspected CCBs assigned were assumed to consist of 25% CCBs.

Attachment 2 presents the calculations, which result in a maximum average percent of CCBs across each exposure area of 18%. Therefore, use of the midpoint would have been a reasonable choice in calculating the percent of CCBs present at each location. To reduce uncertainty and provide for a conservative estimation, the maximum was employed.

Summary

In estimating the percent of CCBs present across each exposure area a conservative approach was taken by using methods that would result in the highest possible estimate, including the following:

- Including in the calculations only those properties on which suspected CCBs were identified;
- Inspecting many locations on each property to identify where suspected CCBs were located;
- Assuming the maximum percent of CCBs in each classification range;
- Using the highest percent CCBs on any property (27%) to represent the percent of CCBs present at all properties, rather than the 95% UCL (8%) or the 90th percentile (15%).

This approach biases all of the calculations toward a higher than actual measure of the percent of CCBs present on residential properties in the Area of Investigation. Using the maximum 27% CCBs in the HHRA provides a conservative estimate of potential exposure and risk in the Area of Investigation. Developing remedial decisions without the use of this critical site-specific information may misguide those decisions.

The exposure point concentrations (EPCs) used in the HHRA were also developed to provide an upper-bound estimate of risk. The EPCs were based on the 95% UCL on the arithmetic mean of the data from the MWSE sampling. This statistical treatment accounts for a 5% chance that specific sample locations may have a concentration greater than the EPC. The calculation of the 95% UCL, using USEPA's ProUCL software, takes into account the variability in the data, for example, where the data are more variable, the 95% UCL will be higher. Therefore, although there may be some locations where an analytical result may be higher than the 95% UCL, that result is unlikely to represent the average concentration across a given property. As described in USEPA guidance, the reasonable maximum exposure (RME) scenario is not meant to define the absolute maximum of all exposure inputs, but rather reasonable upper bounds.

Attachment 1

ProUCL Output for %CCB UCL

	General UCL Statistics for Full Data Sets		
User Selected Options			
From File	WorkSheet.wst		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		
%CCB			
Number of Valid Observations	43	Number of Distinct Observations	43
Raw Statistics		Log-transformed Statistics	
Minimum	0.00182	Minimum of Log Data	-6.31
Maximum	0.274	Maximum of Log Data	-1.296
Mean	0.0677	Mean of log Data	-3.119
Geometric Mean	0.0442	SD of log Data	1.025
Median	0.0519		
SD	0.0636		
Std. Error of Mean	0.0097		
Coefficient of Variation	0.94		
Skewness	1.861		
Relevant UCL Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.799	Shapiro Wilk Test Statistic	0.97
Shapiro Wilk Critical Value	0.943	Shapiro Wilk Critical Value	0.943
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
95% Student's-t UCL	0.084	95% H-UCL	0.109
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.132
95% Adjusted-CLT UCL (Chen-1995)	0.0866	97.5% Chebyshev (MVUE) UCL	0.158
95% Modified-t UCL (Johnson-1978)	0.0844	99% Chebyshev (MVUE) UCL	0.208
Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.239	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	0.0546		
MLE of Mean	0.0677		
MLE of Standard Deviation	0.0608		
nu star	106.6		
Approximate Chi Square Value (.05)	83.74	Nonparametric Statistics	
Adjusted Level of Significance	0.0444	95% CLT UCL	0.0836
Adjusted Chi Square Value	83.04	95% Jackknife UCL	0.084
		95% Standard Bootstrap UCL	0.0838
Anderson-Darling Test Statistic	0.221	95% Bootstrap-t UCL	0.088
Anderson-Darling 5% Critical Value	0.771	95% Hall's Bootstrap UCL	0.0874
Kolmogorov-Smirnov Test Statistic	0.0716	95% Percentile Bootstrap UCL	0.0843
Kolmogorov-Smirnov 5% Critical Value	0.138	95% BCA Bootstrap UCL	0.0863
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.11
		97.5% Chebyshev(Mean, Sd) UCL	0.128
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.164
95% Approximate Gamma UCL (Use when n >= 40)	0.0861		
95% Adjusted Gamma UCL (Use when n < 40)	0.0868		
Potential UCL to Use		Use 95% Approximate Gamma UCL	0.0861
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.			

Attachment 2

Calculation of Percent Suspected CCBs based on Midpoint of Bins

AECOM

1	2	3	4	5	6	7	8	9	10	11	12	13	14
				Number of Locations Surveyed with Suspected CCBs Present (a)									
Property Number	Structure	Suspected CCBs Adjacent to Structure	Total Number of Locations Surveyed	Total	Surface (b)	0-25%	26-50%	51-75%	Conservative Maximum Average Percent of Suspected CCBs Observed at the Ground Surface (a,c)	Approximate Exposure Area (m^2) (d)	Approximate Area of Suspected CCBs Within Exposure Area (m^2) (e)	Percent of Exposure Area with Suspected CCBs (f)	Conservative Maximum Average Percent Suspected CCBs Across the Exposure Area (g)
2	residence	No	71	55	0	47	8	0	16.1%	6,994	6,686	96%	15%
3	residence	Yes	73	42	0	18	24	0	26.8%	4,380	2,920	67%	18%
1	residence	Yes	46	26	0	21	5	0	17.3%	1,064	795	75%	13%
46	none	NA	41	14	0	13	1	0	14.3%	1,752	986	56%	8%
4	residence	Yes	340	59	0	54	4	1	15.0%	7,420	3,989	54%	8%
37	none	NA	25	9	0	8	1	0	15.3%	677	318	47%	7%
38	none	NA	38	19	2	16	1	0	13.8%	1,242	521	42%	6%
10	residence	No	63	6	0	6	0	0	12.5%	1,145	464	41%	5%
34	vacant store	No	88	30	1	29	0	0	12.5%	4,522	1,782	39%	5%
5	residence	Yes	49	19	5	14	0	0	12.5%	1,545	606	39%	5%
41	none	NA	40	7	0	7	0	0	12.5%	1,044	341	33%	4%
6	residence	No	89	14	0	9	2	3	26.8%	3,883	782	20%	5%
7	residence	No	48	13	0	9	4	0	20.2%	1,295	310	24%	5%
33	town hall	No	109	77	0	77	0	0	12.5%	4,886	1,479	30%	4%
47	residence	No	14	3	0	1	2	0	29.2%	766	132	17%	5%
35	fire department	Yes	37	14	3	11	0	0	12.5%	3,956	1,050	27%	3%
18	residence	No	242	32	0	15	14	3	28.1%	22,769	3,436	15%	4%
9	residence	No	61	8	0	7	1	0	15.6%	2,133	441	21%	3%
19	residence	No	116	32	2	30	0	0	12.5%	3,665	827	23%	3%
8	residence	No	52	7	0	7	0	0	12.5%	1,675	362	22%	3%
44	none	NA	157	45	0	44	1	0	13.1%	11,028	2,239	20%	3%
11	residence	No	40	3	0	2	1	0	20.8%	1,800	280	16%	3%
12	residence	No	56	7	0	3	4	0	26.8%	1,887	230	12%	3%
42	none	NA	61	19	0	19	0	0	12.5%	3,633	680	19%	2%
25	residence	No	117	10	1	6	2	1	22.5%	8,973	1,131	13%	3%
17	residence	No	30	1	0	1	0	0	12.5%	822	144	18%	2%
14	residence	No	103	9	0	3	6	0	29.2%	3,396	335	10%	3%
43	none	NA	40	7	0	4	3	0	23.2%	2,292	232	10%	2%
15	residence	No	79	9	1	8	0	0	12.5%	2,316	302	13%	2%
27	residence	No	49	10	4	6	0	0	12.5%	2,592	325	13%	2%
13	residence	No	27	6	3	3	0	0	12.5%	765	89	12%	1%
45	none	NA	54	2	0	1	1	0	25.0%	2,321	147	6%	2%
20	residence	No	88	8	0	8	0	0	12.5%	3,951	335	8%	1%
16	residence	No	29	4	0	4	0	0	12.5%	653	55	8%	1%
30	residence	No	31	4	4	0	0	0	12.5%	1,207	100	8%	1%
21	residence	No	76	2	0	2	0	0	12.5%	2,564	202	8%	1%
22	residence	No	86	5	0	3	0	2	32.5%	3,906	141	4%	1%
26	residence	No	86	4	0	4	0	0	12.5%	3,302	166	5%	1%
23	residence	No	43	1	0	1	0	0	12.5%	1,387	63	5%	1%
24	residence	No	61	4	1	3	0	0	12.5%	2,276	87	4%	0%
28	residence	No	86	7	0	7	0	0	12.5%	6,224	218	4%	0%
29	residence	No	53	3	0	3	0	0	12.5%	1,743	50	3%	0%
31	residence	No	86	3	0	3	0	0	12.5%	3,852	28	1%	0.1%
Total			**3180**	**659**	**27**	**537**	**85**	**10**					
								Average for All Properties:	**16.7%**			**23%**	**4%**
								Range for All Properties:	**12.5 - 32.5%**			**1% - 96%**	**0.1% - 18%**

Notes:
CCB - Coal Combustion By-Product.
GPS - Global Positioning System.
m^2 - square meters.
NA - Not applicable.
(a) - Suspected CCB presence was determined by visually observing a six inch below ground surface core. Each sample was classified as surface, 0-25%, 26-50%, 51-75%, or 76-100%
(No samples were classified as 76-100%). Only samples within each property's exposure area were included. More information about the visual inspections is presented in the RI Report (AECOM, 2010).
(b) - Suspected CCBs were observed on the ground surface but were not present at depth; therefore, percentages were not estimated for these locations.
(c) - Weighted average of the percentage of suspected CCBs present in each sample location. It was conservatively assumed that samples classified as 0-25% contained 12.5% suspected CCBs, samples classified as 26-50% contained 37.5% suspected CCBs, etc. In addition, all surface samples were assumed to contain 12.5% suspected CCBs.
(d) - The exposure area for each property was approximated based on review of property boundaries from tax assessment maps, visual inspection location points based on GPS data and includes maintained right-of-way areas. The exposure area is the area for potential contact with suspected CCBs and, therefore, excludes the area of buildings, pavement, and surface water bodies.
(e) - The area of suspected CCBs within each property was calculated based on the exposure area described in note (d), above. Both suspected CCB locations and inferred suspected CCB locations were included.
(f) - The percent of property area with suspected CCBs is calculated as follows: Approximate Area of Suspected CCBs Within Exposure Area) / (Approximate Exposure Area).
(g) - The reasonable maximum average percent suspected CCBs for each property is calculated as follows:
(Reasonable Maximum Average Percent Suspected CCBs for Locations Where Suspected CCBs Have Been Identified) x (Percent of Exposure Area with Suspected CCBs).

Attachment B – Evaluation of Presence of CCBs in Background Soils

Presence of CCBs in Background Soils

To evaluate the potential contribution of CCBs on the background dataset, Table 1 presents the exposure point concentrations (EPCs) for COPCs (and manganese) in suspected CCBs, and calculates 1% of the EPC. This amount is then subtracted from the background EPCs to generate an estimate of the background EPC without the assumed 1% CCB contribution. As indicated on the table, the impact of including 1% CCBs in the background EPCs is minimal, ranging from 0.4% (manganese) to 5% (aluminum). The background EPCs used in the HHRA are compared below to the values with 1% CCBs subtracted out.

Constituent	Units	Background EPC used in HHRA	Background EPC minus 1% CCBs
Aluminum	mg/kg	6,324	6,025
Arsenic	mg/kg	10	9.8
Iron	mg/kg	19,390	18,581
Manganese	mg/kg	467	465
Thallium	mg/kg	1.38	1.36

The background risk assessment was run using the background EPCs minus 1% CCBs. Table 2 presents the total potential carcinogenic risks (arsenic is the only potentially carcinogenic COPC for background) and Table 3 presents the noncarcinogenic hazards. Attachment 1 presents the risk calculation spreadsheets. The table below presents a comparison of the potential risks and hazards calculated in the HHRA to those calculated in this memorandum after subtracting out 1% CCBs.

Total Risk	Background Soil as Calculated in HHRA	Background Soil with 1% CCB subtracted
Total Potential Carcinogenic Risk (arsenic)	1.85E-05	1.79E-05
Total Hazard Index (aluminum, arsenic, iron, manganese, thallium)	2.1	2.06

The potential risks and hazards associated with background decrease only very slightly after the subtraction of the maximum percentage of CCBs identified in any background sample. Therefore, based on this evaluation, the comparison of potential background risks and hazards to potential Area of Investigation risks and hazards is appropriate.

Tables

TABLE 1
COMPARISON OF SUSPECTED CCB EPCs TO BACKGROUND EPCS ASSUMING 1% CCBS MAY BE PRESENT IN BACKGROUND SOILS
PINES AREA OF INVESTIGATION

Constituent	Units	FOD	Hypothetical Screening Level 100% CCB Scenario EPC (a)	1% CCBs (c)	Background EPC (a)	Background EPC minus 1% CCBs (d)	Potential CCB contribution to Background (e)
ALUMINUM	mg/kg	34 : 34	29874	298.74	6324	6025.26	5%
ARSENIC	mg/kg	34 : 34	28.63	0.29	10.05	9.76	3%
CHROMIUM (HEXAVALENT)	mg/kg	11 : 12	1.162	0.01	NA	NA	NA
COBALT	mg/kg	34 : 34	13.35	0.13	NCOPC	NCOPC	NCOPC
IRON	mg/kg	34 : 34	80948	809.48	19390	18580.52	4%
THALLIUM	mg/kg	21 : 34	1.803	0.02	1.383	1.36	1%
VANADIUM	mg/kg	34 : 34	65.85	0.66	NCOPC	NCOPC	NCOPC
MANGANESE	mg/kg	34 : 34	193.8	1.94	466.8	464.86	0.4%

Notes:
CCB - Coal Combustion By-Product.
EPC - Exposure Point Concentration.
FOD - Frequency of Detection - Number of detected results: Total number of samples after duplicates have been averaged.
NA - Not Analyzed.
NCOPC - Not a Constituent of Potential Concern in background.
(a) - Upper confidence limit on the arithmetic mean.
(b) - During the visual inspections of private properties, the percentage of suspected CCBs mixed with other materials at each location was estimated (see Section 3.7.2 of the RI Report). Based on these field observations, an average percentage of suspected CCBs in surface soils was calculated for each property (taking into account the percent suspected CCBs at each inspection location and the total area of each property upon which suspected CCBs were present). The maximum average percentage of CCBs in surface soils was 27%. See Appendix I.
(c) - To confirm the field visual inspection observations about the absence of CCB materials in the background samples, a subset of five background soil samples representing 20% of the total background dataset, were analyzed for the presence of CCBs. Three of the samples contain less than 0.25% fly ash, and two samples contain bottom ash, one sample at 0.75% and one at 1%. The presence of CCB materials was not identified in two samples. The results indicated that no detectable amounts of fly ash were present in the samples and that bottom ash was identified to comprise less than or equal to 1% of the total sample material in just two of the five samples analyzed (AECOM, 2010a). The maximum percentage of CCBs in background samples was applied to the suspected CCB dataset to show the potential impact of 1% CCBs on the background dataset.
(d) - The potential contribution of 1% CCBs in the background samples is subtracted from the background EPC to estimate the concentration in background without CCBs.
(e) - 1% CCB concentration/Background EPC x 100%.

TABLE 2
TOTAL POTENTIAL CARCINOGENIC RISKS - RME RESIDENT - BACKGROUND SOILS
PINES AREA OF INVESTIGATION

Constituent	Background Soils (Minus 1% CCBs)			
	Ingestion	Dermal	Inhalation	Total
Aluminum	NC	NC	NC	--
Arsenic	1.64E-05	1.55E-06	1.03E-09	1.79E-05
Iron	NC	NC	NC	--
Manganese	NC	NC	NC	--
Thallium	NC	NC	NC	--
Total:	**1.64E-05**	**1.55E-06**	**1.03E-09**	**1.79E-05**

Notes:
NC - Not calculated. Not a potential carcinogen.
NCOPC - Not a Constituent of Potential Concern in this medium.
RME - Reasonable Maximum Exposure.

TABLE 3
TOTAL POTENTIAL HAZARD INDEX - RME RESIDENT - BACKGROUND SOILS
PINES AREA OF INVESTIGATION

	Target Endpoint		Background Soils (Minus 1% CCBs)			
Constituent	**Oral/Dermal**	**Inhalation**	**Ingestion**	**Dermal**	**Inhalation**	**Total**
Aluminum	Nervous System	Nervous system	5.50E-02	1.54E-04	1.51E-04	5.53E-02
Arsenic	Skin, Vascular	Developmental, Vascular, Nervous system	2.97E-01	2.50E-02	8.02E-05	3.22E-01
Iron	Gastrointestinal	--	2.42E-01	6.79E-04	NC	2.43E-01
Manganese	Nervous System	Nervous system	1.77E-01	1.24E-02	1.12E-03	1.90E-01
Thallium	Hair	--	**1.25E+00**	3.49E-03	NC	**1.25E+00**
		Total HI:	2.02E+00	4.17E-02	1.35E-03	**2.06E+00**
			Target Endpoint Analysis			
		Developmental HI (a):	--	--	8.02E-05	8.02E-05
		Gastrointestinal HI (a):	2.42E-01	6.79E-04	--	2.43E-01
		Hair HI (a):	1.25E+00	3.49E-03	--	**1.25E+00**
		Nervous System HI (a):	2.32E-01	1.25E-02	1.35E-03	2.46E-01
		Skin HI (a):	2.97E-01	2.50E-02	--	3.22E-01
		Vascular HI (a):	2.97E-01	2.50E-02	8.02E-05	3.22E-01

Notes:
HI - Hazard Index.
RME - Reasonable Maximum Exposure.
Bold indicates that total HI is greater than one, and a target endpoint analysis is therefore conducted.
Highlighting indicates that the target endpoint specific HI is greater than one. Consitituent/pathway HQ driving exceedance is also highlighted.
(a) - Target organ HI represents the sum of the hazard quotients for constituents with the specified target endpoint via the specified pathway.

Attachment 1

Risk Calculation Spreadsheets

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO

Receptors Evaluated:	
Receptor 1:	Young Child
Receptor 2:	Adult

CARCINOGENIC AND NONCARCINOGENIC ASSUMPTIONS FOR RESIDENT DERMAL CONTACT AND INGESTION OF BACKGROUND SOIL (1% CCB SUBTRACTED OUT)		Assumed Value	Units	Calculated Value
Soil Ingestion Rate	Young Child	200	(mg soil/day)	
Soil Ingestion Rate	Adult	100	(mg soil/day)	
Adherence Factor	Young Child	0.20	(mg/cm^2)	
Adherence Factor	Adult	0.07	(mg/cm^2)	
Skin Exposed	Young Child	2800	(cm^2)	
Skin Exposed	Adult	5700	(cm^2)	
Body Weight	Young Child	15	(kg)	
Body Weight	Adult	70	(kg)	
Exposure Frequency	Young Child	250	(days)/365(days) =	6.85E-01
Exposure Frequency	Adult	250	(days)/365(days) =	6.85E-01
Exposure Duration (cancer)	Young Child	6	(years)/70(years) =	8.57E-02
Exposure Duration (cancer)	Adult	24	(years)/70(years) =	3.43E-01
Exposure Duration (noncancer)	Young Child	6	(years)/6(years) =	1.00E+00
Exposure Duration (noncancer)	Adult	24	(years)/24(years) =	1.00E+00
Lifetime		70	(years)	
Unit Conversion Factor		1.00E-06	(kg/mg)	

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO
CARCINOGENIC ASSESSMENT
DERMAL CONTACT
AND INGESTION OF BACKGROUND SOIL (1% CCB SUBTRACTED OUT)
FOR RESIDENT CHILD AND ADULT

Constituent	Background Soil Concentration (mg/kg-soil)	Oral Absorption Adjustment Factor	Dermal Absorption Adjustment Factor	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	Dermal Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	ADDing Young Child (mg/kg-day)	ADDing Adult (mg/kg-day)	Lifetime Average Daily Dose-Ing. (mg/kg-day)	ADDder Young Child (mg/kg-day)	ADDder Adult (mg/kg-day)	Lifetime Average Daily Dose-Der. (mg/kg-day)	Potential Excess Lifetime Cancer Risk: Ingestion	Dermal Contact	Total
Aluminum	6.03E+03	1	0.001	NA	NA	4.72E-03	2.02E-03	6.74E-03	1.32E-05	8.07E-06	2.13E-05	NC	NC	NC
Arsenic	9.76E+00	1	0.03	1.50E+00	1.50E+00	7.64E-06	3.28E-06	1.09E-05	6.42E-07	3.92E-07	1.03E-06	1.64E-05	1.55E-06	1.79E-05
Iron	1.86E+04	1	0.001	NA	NA	1.45E-02	6.23E-03	2.08E-02	4.07E-05	2.49E-05	6.56E-05	NC	NC	NC
Manganese	4.65E+02	1	0.001	NA	NA	3.64E-04	1.56E-04	5.20E-04	1.02E-06	6.22E-07	1.64E-06	NC	NC	NC
Thallium	1.36E+00	1	0.001	NA	NA	1.07E-06	4.58E-07	1.53E-06	2.99E-09	1.83E-09	4.82E-09	NC	NC	NC
											Total:	**1.64E-05**	**1.55E-06**	**1.79E-05**

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO
NONCARCINOGENIC ASSESSMENT
DERMAL CONTACT
AND INGESTION OF BACKGROUND SOIL (1% CCB SUBTRACTED OUT)
FOR RESIDENT CHILD

Constituent	Background Soil Concentration (mg/kg-soil)	Oral Absorption Adjustment Factor	Dermal Absorption Adjustment Factor	Oral Reference Dose (mg/kg-day)	Dermal Reference Dose (mg/kg-day)	ADDing Young Child (mg/kg-day)	Chronic Average Daily Dose-Ing. (mg/kg-day)	ADDder Young Child (mg/kg-day)	Chronic Average Daily Dose-Der. (mg/kg-day)	Potential Hazard Index Ingestion	Potential Hazard Index Dermal Contact	Potential Hazard Index Total
Aluminum	6.03E+03	1	0.001	1.00E+00	1.00E+00	5.50E-02	5.50E-02	1.54E-04	1.54E-04	5.50E-02	1.54E-04	5.52E-02
Arsenic	9.76E+00	1	0.03	3.00E-04	3.00E-04	8.92E-05	8.92E-05	7.49E-06	7.49E-06	2.97E-01	2.50E-02	3.22E-01
Iron	1.86E+04	1	0.001	7.00E-01	7.00E-01	1.70E-01	1.70E-01	4.75E-04	4.75E-04	2.42E-01	6.79E-04	2.43E-01
Manganese	4.65E+02	1	0.001	2.40E-02	9.60E-04	4.25E-03	4.25E-03	1.19E-05	1.19E-05	1.77E-01	1.24E-02	1.89E-01
Thallium	1.36E+00	1	0.001	1.00E-05	1.00E-05	1.25E-05	1.25E-05	3.49E-08	3.49E-08	1.25E+00	3.49E-03	1.25E+00
									Total:	**2.02E+00**	**4.17E-02**	**2.06E+00**

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO

Receptors Evaluated:	
Receptor :	Resident

CARCINOGENIC AND NONCARCINOGENIC ASSUMPTIONS FOR RESIDENT INHALATION OF BACKGROUND SOILS (1% CCB SUBTRACTED OUT)		**Assumed Value**	**Units**
Exposure Time	Adult	2	(hrs/day)
Exposure Time	Young Child	6	(hrs/day)
Exposure Frequency	Resident	250	(days/year)
Exposure Duration	Adult	24	(years)
Exposure Duration	Young Child	6	(years)
Lifetime	Resident	70	(years)
Averaging Time (cancer)	Resident	613200	(hours) [lifetime (years) * 365 days/year * 24 hours/day]
Averaging Time (noncancer)	Adult	210240	(hours) [exposure duration (years) * 365 days/year * 24 hours/day]
Averaging Time (noncancer)	Young Child	52560	(hours) [exposure duration (years) * 365 days/year * 24 hours/day]
Unit Conversion Factor		1000	ug/mg

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO
CARCINOGENIC ASSESSMENT
INHALATION OF
BACKGROUND SOILS (1% CCB SUBTRACTED OUT)
Resident

Constituent	Background Concentration In Air (mg/m^3 air)	Average Daily Exposure - Child (mg/m^3 air)	Average Daily Exposure - Adult (mg/m^3 air)	Unit Risk Factor (ug/m^3)$^{-1}$	Lifetime Average Daily Exposure (Child + Adult)	Potential Excess Lifetime Cancer Risk (Child + Adult)
Aluminum	4.42E-06	6.49E-08	8.65E-08	NA	1.51E-07	NC
Arsenic	7.03E-09	1.03E-10	1.38E-10	4.30E-03	2.41E-10	1.03E-09
Iron	1.36E-05	1.99E-07	2.65E-07	NA	4.64E-07	NC
Manganese	3.26E-07	4.79E-09	6.39E-09	NA	1.12E-08	NC
Thallium	9.67E-10	1.42E-11	1.89E-11	NA	3.31E-11	NC
				Total:		**1.03E-09**

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO
NONCARCINOGENIC ASSESSMENT
INHALATION OF
BACKGROUND SOILS (1% CCB SUBTRACTED OUT)
Resident

Constituent	Background Concentration In Air (mg/m^3 air)	Average Daily Exposure - Child (mg/m^3 air)	Reference Concentration (mg/m^3)	Potential Hazard Quotient (Child)
Aluminum	4.42E-06	7.57E-07	5.00E-03	1.51E-04
Arsenic	7.03E-09	1.20E-09	1.50E-05	8.02E-05
Iron	1.36E-05	2.32E-06	NA	NC
Manganese	3.26E-07	5.59E-08	5.00E-05	1.12E-03
Thallium	9.67E-10	1.66E-10	NA	NC
				1.35E-03

Attachment C – Post- RI Groundwater Data

AECOM

GROUNDWATER AND SURFACE WATER ANALYTICAL RESULTS
POST-RI (OCTOBER 2008 TO APRIL 2012)
PINES AREA OF INVESTIGATION

		Location ID	MW101	MW101	MW101	MW101	MW101	MW101
		Sample ID	MW101XGW100208S	MW101XGW040809S	MW101XGW102809S	MW101XGW043010D	MW101XGW043010S	MW101XGW051911S
		Sample Date	10/2/2008	4/8/2009	10/28/2009	4/30/2010	4/30/2010	5/19/2011
		Sample Type	N	N	N	FD	N	N
		Matrix	WG	WG	WG	WG	WG	WG
Analyte	CAS	Unit						
BORON	7440-42-8	ug/l	503 J+	947	361	824	767	678
FIELD PARAMETERS								
FIELD DISSOLVED OXYGEN	FDO	mg/l	0.27	0.59	0.27		0.31	0.29
FIELD OXIDATION REDUCTION POTENTIAL	FORP	mv	110.9	219.1	176		431.2	159.4
FIELD PH	FPH	pH units	6.19	6.41	6.27		6.14	6.11
FIELD SPECIFIC CONDUCTIVITY	FSPCOND	uS/cm	818	782	395		761	727
FIELD TEMPERATURE	FTEMP	deg c	18.05	10.39	16.39		12.78	12.01
TURBIDITY	TU	ntu	0.18	0.4	0		0	1.74

AECOM

GROUNDWATER AND SURFACE WATER ANALYTICAL RESULTS
POST-RI (OCTOBER 2008 TO APRIL 2012)
PINES AREA OF INVESTIGATION

		Location ID	MW101	MW101	MW102	MW102	MW102	MW102
		Sample ID	MW101XGW041212S	MW101XGW041212D	MW102XGW100208S	MW102XGW040709S	MW102XGW102809S	MW102XGW043010S
		Sample Date	4/12/2012	4/12/2012	10/2/2008	4/7/2009	10/28/2009	4/30/2010
		Sample Type	N	FD	N	N	N	N
		Matrix	WG	WG	WG	WG	WG	WG
Analyte	CAS	Unit						
BORON	7440-42-8	ug/l	325	316	87.9 J+	73.7	65.9	63.9
FIELD PARAMETERS								
FIELD DISSOLVED OXYGEN	FDO	mg/l	0.21		1.49	1.31	1.11	0.71
FIELD OXIDATION REDUCTION POTENTIAL	FORP	mv	134.3		133.9	228.3	197.1	480.3
FIELD PH	FPH	pH units	6.24		6.05	6.32	6.39	6.33
FIELD SPECIFIC CONDUCTIVITY	FSPCOND	uS/cm	752		289	304	265	259
FIELD TEMPERATURE	FTEMP	deg c	12.47		15.38	9.47	13.85	13.34
TURBIDITY	TU	ntu	0.77		0.11		0	0

GROUNDWATER AND SURFACE WATER ANALYTICAL RESULTS
POST-RI (OCTOBER 2008 TO APRIL 2012)
PINES AREA OF INVESTIGATION

		Location ID	MW102	MW102	MW105	MW105	MW105	MW105
		Sample ID	MW102XGW051911S	MW102XGW041212S	MW105XGW100308D	MW105XGW100308S	MW105XGW040809S	MW105XGW102709S
		Sample Date	5/19/2011	4/12/2012	10/3/2008	10/3/2008	4/8/2009	10/27/2009
		Sample Type	N	N	FD	N	N	N
		Matrix	WG	WG	WG	WG	WG	WG
Analyte	CAS	Unit						
BORON	7440-42-8	ug/l	61.9	93.1	290 J+	317 J+	339	343
FIELD PARAMETERS								
FIELD DISSOLVED OXYGEN	FDO	mg/l	0.39	0.16		0.37	0.5	0.39
FIELD OXIDATION REDUCTION POTENTIAL	FORP	mv	197	150.9		136.3	181.3	174.1
FIELD PH	FPH	pH units	6.37	6.46		6.91	6.32	6.39
FIELD SPECIFIC CONDUCTIVITY	FSPCOND	uS/cm	392	377		376	408	520
FIELD TEMPERATURE	FTEMP	deg c	11.6	12.13		13.02	10.7	12.34
TURBIDITY	TU	ntu	1.25	0.36		0	0.3	0.1

GROUNDWATER AND SURFACE WATER ANALYTICAL RESULTS
POST-RI (OCTOBER 2008 TO APRIL 2012)
PINES AREA OF INVESTIGATION

		Location ID	MW105	MW105	MW105	MW105	MW110	MW110
		Sample ID	MW105XGW042910S	MW105XGW052011S	MW105XGW052011D	MW105XGW041212S	MW110XGW100308S	MW110XGW040709S
		Sample Date	4/29/2010	5/20/2011	5/20/2011	4/12/2012	10/3/2008	4/7/2009
		Sample Type	N	N	FD	N	N	N
		Matrix	WG	WG	WG	WG	WG	WG
Analyte	CAS	Unit						
BORON	7440-42-8	ug/l	264	291	296	356	50.4 J+	129
FIELD PARAMETERS								
FIELD DISSOLVED OXYGEN	FDO	mg/l	0.39	0.5		0.29	2.21	0.56
FIELD OXIDATION REDUCTION POTENTIAL	FORP	mv	421	192		113.4	113.8	69.3
FIELD PH	FPH	pH units	6.32	6.21		6.21	6.35	6.41
FIELD SPECIFIC CONDUCTIVITY	FSPCOND	uS/cm	441	610		529	234	909
FIELD TEMPERATURE	FTEMP	deg c	13.54	12.29		12.48	18.02	8.57
TURBIDITY	TU	ntu	0	1.45		1.64	0.87	

GROUNDWATER AND SURFACE WATER ANALYTICAL RESULTS
POST-RI (OCTOBER 2008 TO APRIL 2012)
PINES AREA OF INVESTIGATION

		Location ID	MW110	MW110	MW110	MW110	MW110	MW123
		Sample ID	MW110XGW102809D	MW110XGW102809S	MW110XGW043010S	MW110XGW052011S	MW110XGW041312S	MW123XGW100308S
		Sample Date	10/28/2009	10/28/2009	4/30/2010	5/20/2011	4/13/2012	10/3/2008
		Sample Type	FD	N	N	N	N	N
		Matrix	WG	WG	WG	WG	WG	WG
Analyte	CAS	Unit						
BORON	7440-42-8	ug/l	93.2	91.4	89.1	50.2	83.3	208 J+
FIELD PARAMETERS								
FIELD DISSOLVED OXYGEN	FDO	mg/l		0.3	0.3	4.42	0.4	0.28
FIELD OXIDATION REDUCTION POTENTIAL	FORP	mv		81.2	486.8	190.5	203.6	-159.7
FIELD PH	FPH	pH units		6.43	6.39	6.6	6.55	7.36
FIELD SPECIFIC CONDUCTIVITY	FSPCOND	uS/cm		600	1078	587	1107	5607
FIELD TEMPERATURE	FTEMP	deg c		15.14	14	11.8	11.28	13.08
TURBIDITY	TU	ntu		0	0.9	1.82	0.25	2.21

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GROUNDWATER AND SURFACE WATER ANALYTICAL RESULTS
POST-RI (OCTOBER 2008 TO APRIL 2012)
PINES AREA OF INVESTIGATION

		Location ID	MW123	MW123	MW123	MW123	MW123	MW123
		Sample ID	MW123XGW040809D	MW123XGW040809S	MW123XGW102709S	MW123XGW042910S	MW123XGW052011S	MW123XGW041312S
		Sample Date	4/8/2009	4/8/2009	10/27/2009	4/29/2010	5/20/2011	4/13/2012
		Sample Type	FD	N	N	N	N	N
		Matrix	WG	WG	WG	WG	WG	WG
Analyte	CAS	Unit						
BORON	7440-42-8	ug/l	146	139	65.7	72.7	144	135
FIELD PARAMETERS								
FIELD DISSOLVED OXYGEN	FDO	mg/l		0.78	0.23	0.31	0.3	6.2
FIELD OXIDATION REDUCTION POTENTIAL	FORP	mv		-59.1	-28.7	66.7	-14.7	-47.4
FIELD PH	FPH	pH units		6.92	6.57	6.59	6.86	6.7
FIELD SPECIFIC CONDUCTIVITY	FSPCOND	uS/cm		4253	2042	1965	3129	2460
FIELD TEMPERATURE	FTEMP	deg c		9.36	12.83	11.68	11.4	12.4
TURBIDITY	TU	ntu		0.8	0.02	0.53	1.51	1.48

GROUNDWATER AND SURFACE WATER ANALYTICAL RESULTS
POST-RI (OCTOBER 2008 TO APRIL 2012)
PINES AREA OF INVESTIGATION

		Location ID	SW009	SW009	SW009	SW009
		Sample ID	SW009XSW100308S	SW009XSW040709S	SW009XSW102709S	SW009XSW042910S
		Sample Date	10/3/2008	4/7/2009	10/27/2009	4/29/2010
		Sample Type	N	N	N	N
		Matrix	WS	WS	WS	WS
Analyte	CAS	Unit				
BORON	7440-42-8	ug/l	444 J+	223	440	377
FIELD PARAMETERS						
FIELD DISSOLVED OXYGEN	FDO	mg/l	7.56	11.98	6.36	8.4
FIELD OXIDATION REDUCTION POTENTIAL	FORP	mv				
FIELD PH	FPH	pH units	7.37	7.23	7.11	7.33
FIELD SPECIFIC CONDUCTIVITY	FSPCOND	uS/cm	676	355	601	485
FIELD TEMPERATURE	FTEMP	deg c	14.12	7.32	11.73	13.53
TURBIDITY	TU	ntu	2.08		3.39	5.19

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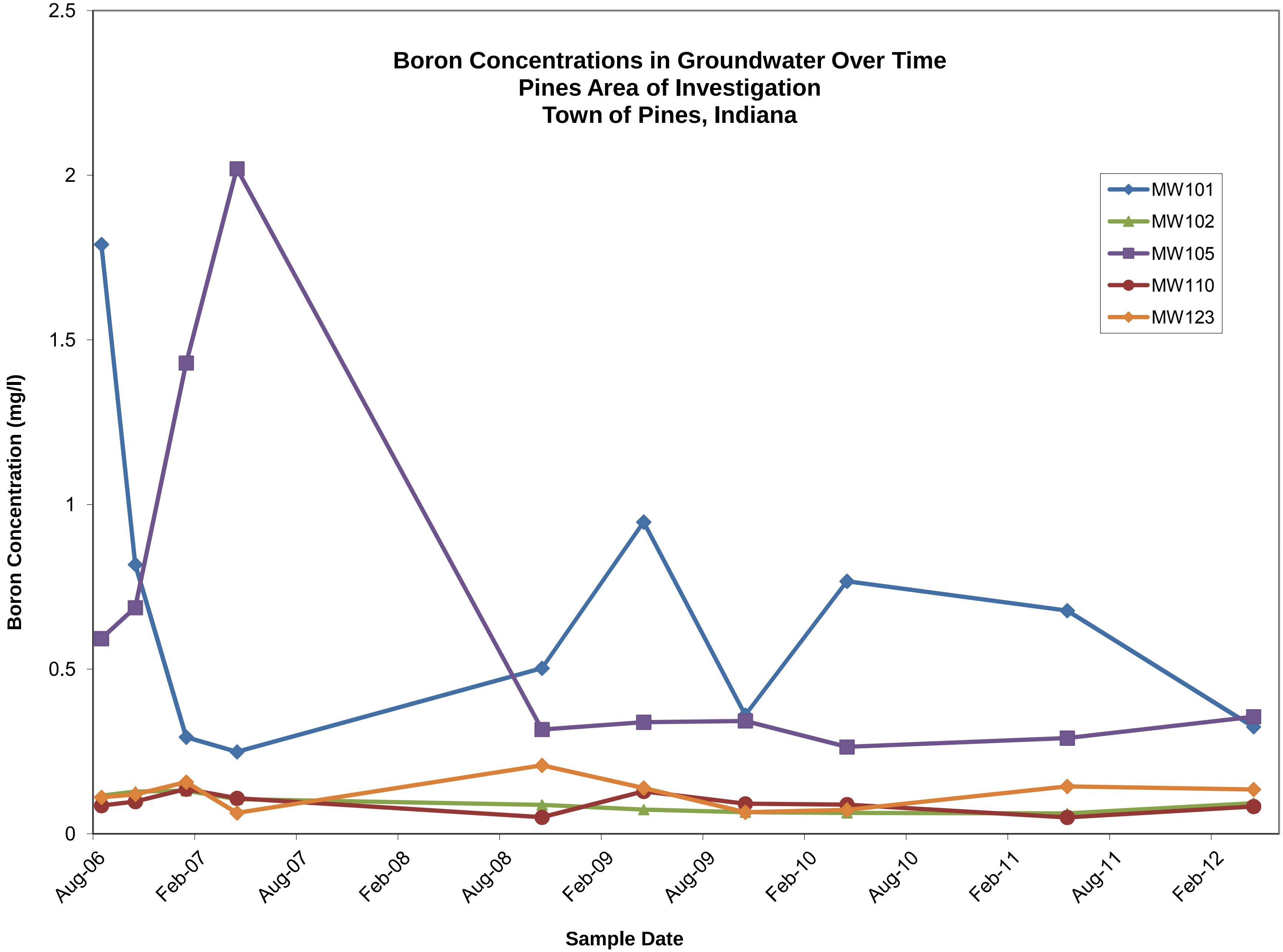
Boron Concentrations in Groundwater Over Time
Pines Area of Investigation
Town of Pines, Indiana
Boron Concentration (mg/l)
2.5
2
1.5
1
0.5
0
MW101
MW102
MW105
MW110
MW123
Aug-06
Feb-07
Aug-07
Feb-08
Aug-08
Feb-09
Aug-09
Feb-10
Aug-10
Feb-11
Aug-11
Feb-12
Sample Date

Attachment D – Post-RI Surface Water and Sediment Human Health Risk Assessment

Post-RI Surface Water and Sediment Evaluation

The results of the October 2, 2011 Yard 520 surface water and sediment sampling were submitted to USEPA in the Progress Report for December 2011, and are shown in Tables 1 and 2 from that report (Attachment 1). The locations of the samples were shown on Figure 1 of the progress report, which is also included in Attachment 1. The results were used to evaluate potential risks and hazards associated with potential exposure to surface water, sediment, and fish tissue by a recreational receptor.

<u>Assumptions</u>

The post-Remedial Investigation (RI) surface water and sediment evaluation was conducted following USEPA guidance and the methods used in the HHRA for the Pines Area of Investigation. Both a recreational child and a recreational fisher were evaluated, because potential constituents of potential concern (COPCs) include both potential carcinogens (where the adult receptor is more sensitive) and noncarcinogens (where the child receptor is more sensitive). The exposure assumptions are the same as those used in the human health risk assessment (HHRA) for wading and fishing scenarios, presented in Tables 5-4 and 5-5 of the HHRA. While the incidental ingestion pathway was not included for surface water in the wading scenarios in the HHRA, it has been included here to address uncertainties raised by the United States Environmental Protection Agency (USEPA) in comments on the HHRA in their March 21, 2012 approval/modification letter on the risk assessments. An ingestion rate of 0.005 mg/L (1/10 the swimming rate identified on Table 5-4 of the HHRA) was used for both the child and the fisher.

<u>Constituent Screen</u>

Table 1 presents a comparison of the post RI sediment data to adjusted residential soil Regional Screening Levels (RSLs) (May 2012). The majority of the constituents detected are below adjusted RSLs and therefore not of concern for the HHRA; concentrations of arsenic and manganese exceed RSLs. However, the concentrations are lower than the Brown Ditch sediment EPCs used in the HHRA as indicated below:

Constituent	Unit	SW032 Sediment Sample	Brown Ditch EPC (Table 5-33 of the HHRA)
Arsenic	mg/kg	7.7	24.16
Manganese	mg/kg	334	529

Therefore, potential risks calculated based on the post-RI sediment data would be lower than those calculated in the HHRA for Brown Ditch and no further evaluation of the post-RI sediment data has been conducted.

Table 2 presents a comparison of the post-RI surface water data (total results) to adjusted tapwater RSLs. The maximum detected concentrations of a few constituents are greater than the adjusted RSLs, and are also greater than the Brown Ditch EPCs used in the HHRA (presented in Table 5-21 of the HHRA). Therefore, these constituents, as listed below, were selected as COPCs for this evaluation:

- arsenic
- boron
- iron
- manganese
- molybdenum

Table 3 presents a fish tissue screen. The same bioconcentration factors (BCFs) used in the HHRA were used in Table 3 to estimate concentrations in fish tissue. Concentrations of the following constituents exceeded fish tissue screening levels and are therefore selected as COPCs:

- arsenic
- manganese
- molybdenum

Results

As only two samples were available for analysis, the exposure point concentrations (EPCs) were equal to the maximum detected concentration for that constituent, as shown on Table 2; the predicted fish tissue EPCs are presented in Table 3.

Attachment 2 provides the risk calculations. Tables 4 through 7 present the total potential risk and hazards for the recreational child and the recreational fisher. A summary of the total potential excess lifetime cancer risk and hazard indices is presented in the table below.

Receptor	Total Potential Risk	Total Potential Hazard Index
Recreational Child	9.8E-7	1.7
Recreational Fisher	3.7E-06	1.4

The total potential risk for the recreational child is below the USEPA target risk range of 1E-6 to 1E-4; the total potential risk for the recreational fisher is within the range of 1E-6 to 1E-4 and is above 1E-6 due to potential ingestion of fish based on predicted arsenic content. The hazard index (HI) for both receptors is above one, due to potential ingestion of fish based on predicted manganese content. The results presented here are based on the maximum constituent concentrations for the two samples. Fish tissue exceedances were not identified in the HHRA based on the RI surface water data, and these results are not of concern because fishing (and subsequent fish ingestion) is not a common use of Brown Ditch.

It should be noted that manganese is also present in upgradient surface water samples. As noted in the Remedial Investigation Report (March 5, 2010), manganese was detected in all 44 upgradient surface water samples analyzed for total manganese. Total manganese concentrations in the upgradient samples ranged from 38.4 ug/L to 2,570 ug/l; with an average of 197 ug/L. More recent upgradient surface water samples (SW001 and SW002) are also within this range. The maximum detected concentration used to calculate the potential HIs in this risk evaluation of 571 ug/L is within the range of the concentrations detected in upgradient surface water samples.

Tables

TABLE 1
SCREEN OF VALIDATED SEDIMENT SAMPLING ANALYTICAL RESULTS FOR SAMPLES COLLECTED IN OCTOBER 2011
PINES AREA OF INVESTIGATION

Constituent	Unit	SW032 10/5/2011 SW032XSD100511S Sediment Sample	Residential Screening Level (a) (mg/kg)	Basis	Is Detected Concentration >RSL?
ALUMINUM	mg/kg	5130	7700	NC	No
ARSENIC	mg/kg	7.7	0.39	C	Yes
BARIUM	mg/kg	176	1500	NC	No
BORON	mg/kg	18	1600	NC	No
CADMIUM	mg/kg	0.500 U	7	NC	ND
CALCIUM	mg/kg	94500	EN		--
CHROMIUM	mg/kg	5.6	12000 (b)	NC	No
COPPER	mg/kg	5.7	310	NC	No
IRON	mg/kg	3010	5500	NC	No
LEAD	mg/kg	8.2	400	(d)	No
MAGNESIUM	mg/kg	15200	EN		--
MANGANESE	mg/kg	334	180	NC	Yes
MOLYBDENUM	mg/kg	8.1	39	NC	No
NICKEL	mg/kg	5.3	150	NC	No
POTASSIUM	mg/kg	644	EN		--
SELENIUM	mg/kg	1.0 U	39	NC	ND
SILICON (SW6010C)	mg/kg	1650	NA		--
SILICON (E300)	mg/kg	260 U	NA		--
SODIUM	mg/kg	712	EN		--
STRONTIUM	mg/kg	270	4700	NC	No
THALLIUM	mg/kg	9.9 U	0.078	NC	ND
URANIUM-238	mg/kg	1	23	NC	No
VANADIUM	mg/kg	10	39	NC	No
ZINC	mg/kg	123	2300	NC	No

Notes:
C - RSL is based on potentially carcinogenic effects.
EN - Essential Nutrient.
ND - Not detected.
NC - RSL is based on noncarcinogenic effects.
RSL - Regional Screening Level.
USEPA - United States Environmental Protection Agency.
U - The analyte was analyzed for, but was not detected above the sample reporting limit
(a) - Regional Screening Levels for Chemical Contaminants at Superfund Sites. May 2012. http://www.epa.gov/region09/superfund/prg/index.html. Values for residential soil.
If RSL is based on a noncancer endpoint, the RSL is adjusted to a hazard quotient of 0.1 by multiplying the RSL by 0.1. The risk level is 1E-6 if the RSL is based on a cancer endpoint.
(b) - RSL for trivalent chromium.

TABLE 2
SCREEN OF VALIDATED SURFACE WATER SAMPLING ANALYTICAL RESULTS FOR SAMPLES COLLECTED IN OCTOBER 2011
PINES AREA OF INVESTIGATION

Constituent	FOD	Low FOD? (d)	Minimum Detect (ug/L)	Maximum Detect (ug/L)	Mean Detect (a) (ug/L)	Tapwater Screening Level (b) (ug/L)	Basis	Maximum Contaminant Level (c) (ug/L)	Is Maximum Detected Concentration >RSL?	COPC?	Reason
ALUMINUM	2 : 2	No	119	730	425	1600	NC	--	No	No	Maximum detect < RSL
ARSENIC	2 : 2	No	1.7	12.2	7	0.045	C	10	Yes	Yes	Maximum detect > RSL
BARIUM	2 : 2	No	36.6	139	88	290	NC	2000	No	No	Maximum detect < RSL
BORON	2 : 2	No	405	3020	1713	310	NC	--	Yes	Yes	Maximum detect > RSL
CALCIUM	2 : 2	No	29600	97500	63550	EN		--	--	No	EN
IRON	2 : 2	No	417	2990	1704	1100	NC	--	Yes	Yes	Maximum detect > RSL
MAGNESIUM	2 : 2	No	8370	32400	20385	EN		--	--	No	EN
MANGANESE	2 : 2	No	66.7	571	318.9	32	NC	--	Yes	Yes	Maximum detect > RSL
MERCURY	0 : 2	No	ND (0.2)	ND (0.2)	ND (0.2)	0.43	NC	2	No	No	Maximum detect < RSL
MOLYBDENUM	2 : 2	No	54.5	1310	682.25	7.8	NC	--	Yes	Yes	Maximum detect > RSL
POTASSIUM	2 : 2	No	18100	48100	33100	EN		--	--	No	EN
SELENIUM	1 : 2 (e)	No	0.319	0.319	0.319	7.8	NC	50	No	No	Maximum detect < RSL
SILICON	2 : 2	No	6110	6640	6375	NA		--	--	No	No RSL or dose-response value available.
SODIUM	2 : 2	No	191000	276000	233500	EN		--	--	No	EN
STRONTIUM	2 : 2	No	187	429	308	930	NC	--	No	No	Maximum detect < RSL
VANADIUM	2 : 2	No	0.774	1.9	1.3	7.8	NC	--	No	No	Maximum detect < RSL

Notes:
C - RSL is based on potentially carcinogenic effects.
COPC - Constituent of Potential Concern.
EN - Essential Nutrient.
FOD - Frequency of Detection - Number of detected results: Total number of samples after duplicates have been averaged.
MCL - Maximum Contaminant Level.
NA - Not Available. No dose-response values available to calculate RSL.
ND - Not detected. Value in parenthesis is the reporting limit.
NC - RSL is based on noncarcinogenic effects.
RSL - Regional Screening Level.
USEPA - United States Environmental Protection Agency.
(a) - Arithmetic mean using detected results only.
(b) - Regional Screening Levels for Chemical Contaminants at Superfund Sites. May 2012. http://www.epa.gov/region09/superfund/prg/index.html. Values for tapwater.
If RSL is based on a noncancer endpoint, the RSL is adjusted to a hazard quotient of 0.1 by multiplying the RSL by 0.1. The risk level is 1E-6 if the RSL is based on a cancer endpoint.
(c) - USEPA Maximum Contaminant Level. 2012 Edition of the Drinking Water Standards and Health Advisories.
(d) - FOD is defined as low where at least 20 samples are available and constituent was detected in fewer than 5% of the samples.
(e) - The reporting limit for the sample reported as not detected for selenium is 2 ug/L.

TABLE 3
SCREEN OF VALIDATED SURFACE WATER SAMPLING ANALYTICAL RESULTS FOR SAMPLES COLLECTED IN OCTOBER 2011 - FISH TISSUE
PINES AREA OF INVESTIGATION

Constituent	Surface Water FOD	Low FOD? (h)	Surface Water Maximum Detect (mg/L)	Water-to-Fish Uptake Factor [(mg constituent/kg fish ww)/ (mg constituent/L water)]		Estimated Maximum Fish Tissue Concentration (f) (mg/kg ww)	Fish Tissue Screening Level (g) (mg/kg ww)	Basis	Is Modeled Fish Tissue Concentration >RSL?	COPC?	Reason
Brown Ditch											
ALUMINUM	2 : 2	No	0.73	2.7	(a)	1.971	140	NC	No	No	Modeled concentration < RSL
ARSENIC	2 : 2	No	0.0122	3.46	(a)	0.042212	0.0021	C	Yes	Yes	Modeled concentration > RSL
BARIUM	2 : 2	No	0.139	4	(d)	0.556	27	NC	No	No	Modeled concentration < RSL
BORON	2 : 2	No	3.02	1	(c)	3.02	27	NC	No	No	Modeled concentration < RSL
CALCIUM	2 : 2	No	97.5	(j)		--	(j)		--	No	EN
IRON	2 : 2	No	2.99	1	(d)	2.99	95	NC	No	No	Modeled concentration < RSL
MAGNESIUM	2 : 2	No	32.4	(j)		--	(j)		--	No	EN
MANGANESE	2 : 2	No	0.571	400	(d)	228.4	19	NC	Yes	Yes	Modeled concentration > RSL
MERCURY	0 : 2	No	ND	--		--	--		--	No	ND
MOLYBDENUM	2 : 2	No	1.31	2.3	(a,b)	3.013	0.68	NC	Yes	Yes	Modeled concentration > RSL
POTASSIUM	2 : 2	No	48.1	(j)		--	(j)		--	No	EN
SELENIUM	0 : 2	No	ND	485	(a)	--	0.68	NC	--	No	ND
SILICON	2 : 2	No	6.64	--		--	NA	--	--	No	No RSL or dose-response value available.
SODIUM	2 : 2	No	276	(j)		--	(j)		--	No	EN
STRONTIUM	2 : 2	No	0.429	1	(e)	0.429	81	NC	No	No	Modeled concentration < RSL
VANADIUM	0 : 2	No	ND	0.01	(d)	--	0.68	NC	--	No	ND

Notes:
C - RSL is based on potentially carcinogenic effects.
COPC - Constituent of Potential Concern.
EN - Essential Nutrient.
FOD - Frequency of Detection - Number of detected results: Total number of samples after duplicates have been averaged. Only constituents with at least one detected result are included on table.
NA - Not Available. No dose-response values available to calculate RSL.
NC - RSL is based on noncarcinogenic effects.
ND - Not detected.
RSL - Regional Screening Level.
SW - Surface Water.
USEPA - United States Environmental Protection Agency.
ww- wet weight.
(a) - Surface water to fish bioconcentration factors described in Appendix I of *Draft Final Report Non-Groundwater Pathways, Human Health and Ecological Risk Analysis for Fossil Fuel Combustion Phase 2* (USEPA, 1998d).
(b) - Value for muscle tissue.
(c) - Studies by Thompson et al., (1976) found no evidence of active boron bioaccumulation in sockey salmon or Pacific oyster. Tissue levels approximated water levels.
(d) - Surface water to fish bioconcentration factors described in *Bioaccumulation and Bioconcentration Screening Protocol* developed for the Savannah River Site (WSRC, 1999).
(e) - Default value presented in *Bioaccumulation and Bioconcentration Screening Protocol* developed for the Savannah River Site (WSRC, 1999).
(f) - Tissue concentration calculated by:
Concentration in fish (mg constituent/kg fish ww) = Concentration in water (mg constituent /L water)
x Uptake Factor ((mg constituent/kg fish ww)/(mg constituent/L water)) x FCM_{TL2} x FCM_{TL3}
Where FCM_{TL2} and FCM_{TL3} = 1 for all inorganic constituents (USEPA, 1995c).
(g) - USEPA Region 3 Fish Tissue Screening Levels. May 2012. URL: [http://www.epa.gov/reg3hwmd/risk/human/index.htm].
If RSL is based on a noncancer endpoint, the RSL is adjusted to a hazard quotient of 0.1 by multiplying the RSL by 0.1. The risk level is 1E-6 if the RSL is based on a cancer endpoint.
(h) - FOD is defined as low where at least 20 samples are available and constituent was detected in fewer than 5% of the samples.
(i) - Background evaluation provided in Appendix D.

TABLE 4
TOTAL POTENTIAL CARCINOGENIC RISKS - RME RECREATIONAL CHILD - OCTOBER 2011 SURFACE WATER DATA
PINES AREA OF INVESTIGATION

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Constituent	Brown Ditch Surface Water (Wading)			Brown Ditch Fish	Total
	Ingestion	Dermal	Total	Ingestion	
Arsenic	3.72E-08	4.17E-08	7.90E-08	9.05E-07	9.84E-07
Boron	NA	NC	NC	NC	--
Iron	NA	NC	NC	NC	--
Manganese	NA	NC	NC	NC	--
Molybdenum	NA	NC	NC	NC	--
Total:	**3.72E-08**	**4.17E-08**	**7.90E-08**	**9.05E-07**	**9.84E-07**

Notes:
CCB - Coal Combustion By-Product.
NC - Not calculated. Not a potential carcinogen.
NCOPC - Not a Constituent of Potential Concern in this medium.
RME - Reasonable Maximum Exposure.

TABLE 5
TOTAL POTENTIAL HAZARD INDEX - RME RECREATIONAL CHILD - OCTOBER 2011 SURFACE WATER DATA
PINES AREA OF INVESTIGATION

	Target Endpoint	Brown Ditch Surface Water (Wading)			Brown Ditch Fish	
Constituent	**Oral/Dermal**	**Ingestion**	**Dermal**	**Total**	**Ingestion**	**Total**
Arsenic	Skin, Vascular	9.66E-04	1.08E-03	2.05E-03	2.35E-02	2.55E-02
Boron	Developmental	3.59E-04	4.02E-04	7.60E-04	NCOPC	7.60E-04
Iron	Gastrointestinal	1.01E-04	1.14E-04	2.15E-04	NCOPC	2.15E-04
Manganese	Nervous System	5.65E-04	1.58E-02	1.64E-02	**1.59E+00**	1.60E+00
Molybdenum	Kidney	6.22E-03	6.97E-03	1.32E-02	1.00E-01	1.14E-01
Total		**8.21E-03**	**2.44E-02**	**3.26E-02**	**1.71E+00**	**1.74E+00**
	Developmental HI (a):	3.59E-04	4.02E-04	7.60E-04	NCOPC	7.60E-04
	Gastrointestinal HI (a):	1.01E-04	1.14E-04	2.15E-04	NCOPC	2.15E-04
	Kidney HI (a):	6.22E-03	6.97E-03	1.32E-02	1.00E-01	1.14E-01
	Nervous System HI (a):	5.65E-04	1.58E-02	1.64E-02	**1.59E+00**	**1.60E+00**
	Skin HI (a):	9.66E-04	1.08E-03	2.05E-03	2.35E-02	2.55E-02
	Vascular HI (a):	9.66E-04	1.08E-03	2.05E-03	2.35E-02	2.55E-02

Notes:
CCB - Coal Combustion By-Product.
HI - Hazard Index.
NC - Not calculated. No dose-response value available.
NCOPC - Not a Constituent of Potential Concern in this medium.
RME - Reasonable Maximum Exposure.
(a) - Target organ HI represents the sum of the hazard quotients for constituents with the specified target endpoint via the specified pathway.

TABLE 6
TOTAL POTENTIAL CARCINOGENIC RISKS - RME RECREATIONAL FISHER - SURFACE WATER DATA OCTOBER 2011
PINES AREA OF INVESTIGATION

Constituent	Brown Ditch Surface Water			Brown Ditch Fish	
	Ingestion	Dermal	Total	Ingestion	Total
Arsenic	3.99E-08	4.52E-08	8.51E-08	3.57E-06	3.65E-06
Boron	NA	NC	NC	NCOPC	--
Iron	NA	NC	NC	NCOPC	--
Manganese	NA	NC	NC	NC	--
Molybdenum	NA	NC	NC	NC	--
Total:	**3.99E-08**	**4.52E-08**	**8.51E-08**	**3.57E-06**	**3.65E-06**

Notes:
CCB - Coal Combustion By-Product.
MWSE - Municpal Water Service Line Extension.
NC - Not calculated. Not a potential carcinogen.
NCOPC - Not a Constituent of Potential Concern in this medium.
RME - Reasonable Maximum Exposure.

TABLE 7
TOTAL POTENTIAL HAZARD INDEX - RME RECREATIONAL FISHER - SURFACE WATER DATA OCTOBER 2011
PINES AREA OF INVESTIGATION

	Target Endpoint	Brown Ditch Surface Water			Brown Ditch Fish	
Constituent	**Oral/Dermal**	**Ingestion**	**Dermal**	**Total**	**Ingestion**	**Total**
Arsenic	Skin, Vascular	2.07E-04	2.35E-04	4.42E-04	1.85E-02	1.89E-02
Boron	Developmental	7.68E-05	8.71E-05	1.64E-04	NCOPC	1.64E-04
Iron	Gastrointestinal	2.17E-05	2.46E-05	4.64E-05	NCOPC	4.64E-05
Manganese	Nervous System	1.21E-04	3.43E-03	3.55E-03	**1.25E+00**	1.25E+00
Molybdenum	Kidney	1.33E-03	1.51E-03	2.84E-03	7.92E-02	8.20E-02
Total		1.76E-03	5.29E-03	7.05E-03	**1.35E+00**	**1.36E+00**
Target Endpoint Analysis						
	Developmental HI (a):	7.68E-05	8.71E-05	1.64E-04	NCOPC	1.64E-04
	Gastrointestinal HI (a):	2.17E-05	2.46E-05	4.64E-05	NCOPC	4.64E-05
	Kidney HI (a):	1.33E-03	1.51E-03	2.84E-03	7.92E-02	8.20E-02
	Nervous System HI (a):	1.21E-04	3.43E-03	3.55E-03	**1.25E+00**	**1.25E+00**
	Skin HI (a):	2.07E-04	2.35E-04	4.42E-04	1.85E-02	1.89E-02
	Vascular HI (a):	2.07E-04	2.35E-04	4.42E-04	1.85E-02	1.89E-02

Notes:
CCB - Coal Combustion By-Product.
HI - Hazard Index.
NC - Not calculated. No dose-response value available.
NCOPC - Not a Constituent of Potential Concern in this medium.
RME - Reasonable Maximum Exposure.
(a) - Target organ HI represents the sum of the hazard quotients for constituents with the specified target endpoint via the specified pathway.

Attachment 1

USEPA Progress Report for December 2011 Tables 1 and 2 and Figure 1

TABLE 1
VALIDATED SEDIMENT SAMPLING ANALYTICAL RESULTS
FOR SAMPLES COLLECTED IN OCTOBER 2011
PINES AREA OF INVESTIGATION
PROGRESS REPORT -- NOVEMBER 2011

		Location ID	SW032
		Sample Date	10/5/2011
		Sample ID	SW032XSD100511S
		Sample Matrix	Sediment
		Sample Type	Sample
CAS	**Chemical Name**	**Unit**	
Metals			
7429-90-5	ALUMINUM	mg/kg	5130
7440-38-2	ARSENIC	mg/kg	7.7 J
7440-39-3	BARIUM	mg/kg	176
7440-42-8	BORON	mg/kg	18 J-
7440-43-9	CADMIUM	mg/kg	0.500 U
7440-70-2	CALCIUM	mg/kg	94500
7440-47-3	CHROMIUM	mg/kg	5.6
7440-50-8	COPPER	mg/kg	5.7
7439-89-6	IRON	mg/kg	3010
7439-92-1	LEAD	mg/kg	8.2
7439-95-4	MAGNESIUM	mg/kg	15200
7439-96-5	MANGANESE	mg/kg	334
7439-98-7	MOLYBDENUM	mg/kg	8.1
7440-02-0	NICKEL	mg/kg	5.3
7440-09-7	POTASSIUM	mg/kg	644
7782-49-2	SELENIUM	mg/kg	1.0 U
7440-21-3	SILICON (SW6010C)	mg/kg	1650
7440-21-3	SILICON (E300)	mg/kg	260 U
7440-23-5	SODIUM	mg/kg	712
7440-24-6	STRONTIUM	mg/kg	270
7440-28-0	THALLIUM	mg/kg	9.9 U
7440-61-1	URANIUM-238	mg/kg	1.0 J
7440-62-2	VANADIUM	mg/kg	10.0
7440-66-6	ZINC	mg/kg	123
Carbon			
7440-44-0	DISSOLVED ORGANIC CARBON	mg/kg	64900
TIC	TOTAL INORGANIC CARBON	mg/kg	51900
TOC	TOTAL ORGANIC CARBON	mg/kg	13000

Notes:

CAS - Chemical Abstract Service

ID - Identifier

mg/kg - milligrams per killogram

U - The analyte was analyzed for, but was not detected above the sample reporting limit

J - The result is an estimated quantity; the associated numerical value is the approximate concentration of the analyte in the sample

J- - The result is an estimated quantity, but the result may be biased low

TABLE 2
VALIDATED SURFACE WATER SAMPLING ANALYTICAL RESULTS
FOR SAMPLES COLLECTED IN OCTOBER 2011
PINES AREA OF INVESTIGATION
PROGRESS REPORT -- NOVEMBER 2011

		Location ID	SW032	SW032	SW033	SW033
		Sample Date	10/5/2011	10/5/2011	10/5/2011	10/5/2011
		Sample ID	SW032XSW100511S	SW032XSW100511S DISSOLVED	SW033XSW100511S	SW033XSW100511S DISSOLVED
		Fraction	Total	Dissolved	Total	Dissolved
		Sample Matrix	WS	WS	WS	WS
		Sample Type	N	N	N	N
CAS Number	**Chemical Name**	**Unit**				
Other Inorganic Parameters						
ALKB	ALKALINITY (BICARBONATE)	mg/l	168	--	331	--
ALKC	ALKALINITY (CARBONATE)	mg/l	58.0	--	2.0 U	--
ALK	ALKALINITY, TOTAL (AS CACO3)	mg/l	226	--	331	--
7664-41-7	AMMONIA	mg/l	6.57	--	5.86	--
16887-00-6	CHLORIDE	mg/l	214	--	368	--
16984-48-8	FLUORIDE	mg/l	0.56	--	0.21	--
14797-55-8	NITRATE AS NITROGEN	mg/l	1.0 U	--	1.0 U	--
14265-44-2	ORTHOPHOSPHATE AS PHOSPHATE	mg/l	0.0238 J-	--	0.0198 J-	--
14808-79-8	SULFATE	mg/l	52.2	--	88.1	--
TSS	TOTAL SUSPENDED SOLIDS	mg/l	27.4	--	8.4	--
Metals						
7429-90-5	ALUMINUM	ug/l	730	89.2 J	119	100 U
7440-38-2	ARSENIC	ug/l	12.2	12.0	1.7	0.734 J
7440-39-3	BARIUM	ug/l	36.6	29.6 U	139	134
7440-42-8	BORON	ug/l	405	371	3020	2860
7440-70-2	CALCIUM	ug/l	29600	25500	97500	94900
7439-89-6	IRON	ug/l	417	99.0 J	2990	1600
7439-95-4	MAGNESIUM	ug/l	8370	7610	32400	30900
7439-96-5	MANGANESE	ug/l	66.7	33.9	571	512
7439-97-6	MERCURY	ug/l	0.200 U	0.200 U	0.200 U	0.200 U
7439-98-7	MOLYBDENUM	ug/l	1310	1330	54.5	36.9
7440-09-7	POTASSIUM	ug/l	48100	48100	18100	15400
7782-49-2	SELENIUM	ug/l	2.0 U	2.0 U	0.319 J	0.222 J
7440-21-3	SILICON	ug/l	6110	5320	6640	5860
7440-23-5	SODIUM	ug/l	191000	190000	276000	282000
7440-24-6	STRONTIUM	ug/l	187	177	429	405
7440-62-2	VANADIUM	ug/l	1.9 J	1.7 J	0.774 J	2.0 U
Field Parameters						
DBWS	DEPTH BELOW WATER SURFACE	in	3	--	6	--
FDO	FIELD DISSOLVED OXYGEN	mg/l	3.45	--	9.78	--
FORP	FIELD OXIDATION REDUCTION POTENTIAL	mv	-130.7	--	-726	--
FPH	FIELD PH	pH units	9.38	--	7.28	--
FSPCOND	FIELD SPECIFIC CONDUCTIVITY	uS/cm	1261	--	2088	--
FTEMP	FIELD TEMPERATURE	deg c	11.4	--	11.91	--
TU	TURBIDITY	ntu	14.5	--	0	--

Notes:
CAS - Chemical Abstract Service
ID - Identifier
mg/L - milligrams per liter
ug/L - micrograms per liter
U - The analyte was analyzed for, but was not detected above the sample reporting limit
J - The result is an estimated quantity; the associated numerical value is the approximate concentration of the analyte in the sample
J- - The result is an estimated quantity, but the result may be biased low

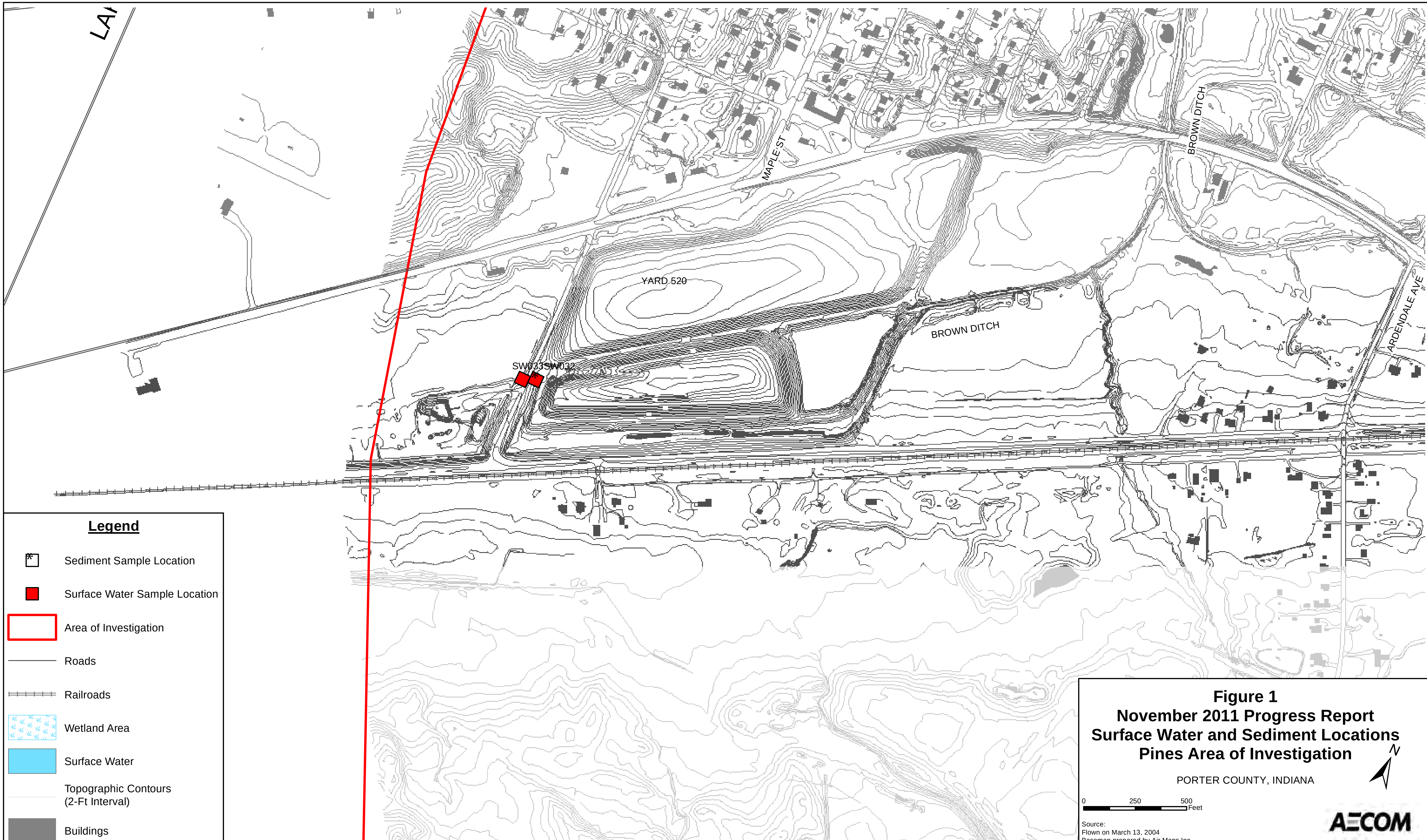

Figure 1
November 2011 Progress Report
Surface Water and Sediment Locations
Pines Area of Investigation

PORTER COUNTY, INDIANA

Source:
Flown on March 13, 2004
Basemap prepared by Air Maps Inc.

AECOM

November 2011

Attachment 2

Risk Calculation Spreadsheets

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO

Receptors Evaluated:	
Receptor 1:	Recreational Child

CARCINOGENIC AND NONCARCINOGENIC ASSUMPTIONS FOR RECREATIONAL CHILD DERMAL CONTACT WITH BROWN DITCH SURFACE WATER WHILE WADING		**Assumed Value**	**Units**	**Calculated Value**
Water Ingestion Rate	Recreational Child	0.005	(l/day)	
Skin Exposed	Recreational Child	2800	(cm^2)	
Body Weight	Recreational Child	15	(kg)	
Exposure Time	Recreational Child	2	(hr/day)	
Exposure Frequency	Recreational Child	26	(days)/365 (days) =	7.12E-02
Exposure Duration (cancer)	Recreational Child	6	(yrs)/ 70(yrs) =	8.57E-02
Exposure Duration (noncancer)	Recreational Child	6	(yrs)/ 6(yrs) =	1.00E+00
Lifetime		70	(years)	
Unit Conversion Factor		0.001	(l/cm^3)	

AECOM

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO
CARCINOGENIC ASSESSMENT
DERMAL CONTACT
WITH BROWN DITCH SURFACE WATER WHILE WADING
RECREATIONAL CHILD

Constituent	Brown Ditch Surface Water Concentration (mg/L)	Dermal Permeability Constant (cm/hr)	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	Dermal Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	ADDing Recreational Child (mg/kg-day)	ADDder Recreational Child (mg/kg-day)	Potential Excess Lifetime Cancer Risk Ingestion	Potential Excess Lifetime Cancer Risk Dermal Contact	Potential Excess Lifetime Cancer Risk Total
Arsenic	1.22E-02	1.00E-03	1.50E+00	1.50E+00	2.48E-08	2.78E-08	3.72E-08	4.17E-08	7.90E-08
Boron	3.02E+00	1.00E-03	NA	NA	6.15E-06	6.88E-06	NA	NC	NC
Iron	2.99E+00	1.00E-03	NA	NA	6.09E-06	6.82E-06	NA	NC	NC
Molybdenum	1.31E+00	1.00E-03	NA	NA	2.67E-06	2.99E-06	NA	NC	NC
Manganese	5.71E-01	1.00E-03	NA	NA	1.16E-06	1.30E-06	NA	NC	NC
						Total:	**3.72E-08**	**4.17E-08**	**7.90E-08**

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO
NONCARCINOGENIC ASSESSMENT
DERMAL CONTACT
WITH BROWN DITCH SURFACE WATER WHILE WADING
RECREATIONAL CHILD

AECOM

Constituent	Brown Ditch Surface Water Concentration (mg/L)	Dermal Permeability Constant (cm/hr)	Oral Reference Dose (mg/kg-day)	Dermal Reference Dose (mg/kg-day)	ADDing Recreational Child (mg/kg-day)	ADDder Recreational Child (mg/kg-day)	Potential Hazard Quotient Ingestion	Potential Hazard Quotient Dermal Contact	Potential Hazard Quotient Total
Arsenic	1.22E-02	1.00E-03	3.00E-04	3.00E-04	2.90E-07	3.24E-07	9.66E-04	1.08E-03	2.05E-03
Boron	3.02E+00	1.00E-03	2.00E-01	2.00E-01	7.17E-05	8.03E-05	3.59E-04	4.02E-04	7.60E-04
Iron	2.99E+00	1.00E-03	7.00E-01	7.00E-01	7.10E-05	7.95E-05	1.01E-04	1.14E-04	2.15E-04
Molybdenum	1.31E+00	1.00E-03	5.00E-03	5.00E-03	3.11E-05	3.48E-05	6.22E-03	6.97E-03	1.32E-02
Manganese	5.71E-01	1.00E-03	2.40E-02	9.60E-04	1.36E-05	1.52E-05	5.65E-04	1.58E-02	1.64E-02
						Total:	**8.21E-03**	**2.44E-02**	**3.26E-02**

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO

Receptors Evaluated:

Receptor 1:	Recreational Child

CARCINOGENIC AND NONCARCINOGENIC ASSUMPTIONS FOR RECREATIONAL CHILD INGESTION OF BROWN DITCH FISH		Assumed Value	Units	Calculated Value
Fish Ingestion Rate	Recreational Child	0.0025	(kg fish/day)	
Body Weight	Recreational Child	15	(kg)	
Exposure Frequency	Recreational Child	365	(days)/ 365 (days) =	1.00E+00
Exposure Duration (cancer)	Recreational Child	6	(yrs)/ 70 (yrs) =	8.57E-02
Exposure Duration (noncancer)	Recreational Child	6	(yrs)/ 6 (yrs) =	1.00E+00
Lifetime		70	(years)	

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO
CARCINOGENIC ASSESSMENT
RECREATIONAL CHILD
BROWN DITCH FISH INGESTION

AECOM

Constituent	Concentration In Fish Tissue (mg/kg)	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	ADDing Recreational Child (mg/kg-day)	Excess Lifetime Cancer Risk
Arsenic	4.22E-02	1.50E+00	6.03E-07	9.05E-07
Manganese	2.28E+02	NA	3.26E-03	NC
Molybdenum	3.01E+00	NA	4.30E-05	NC
			Total:	9.05E-07

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO
NONCARCINOGENIC ASSESSMENT
RECREATIONAL CHILD
BROWN DITCH FISH INGESTION

Constituent	Concentration In Fish Tissue (mg/kg)	Oral Reference Dose (mg/kg-day)	ADDing Recreational Child (mg/kg-day)	Hazard Index
Arsenic	4.22E-02	3.00E-04	7.04E-06	2.35E-02
Manganese	2.28E+02	2.40E-02	3.81E-02	1.59E+00
Molybdenum	3.01E+00	5.00E-03	5.02E-04	1.00E-01
			Total:	1.71E+00

AECOM

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO

Receptors Evaluated:

Receptor 1:	Recreational Fisher

CARCINOGENIC AND NONCARCINOGENIC ASSUMPTIONS FOR RECREATIONAL FISHER DERMAL CONTACT WITH BROWN DITCH SURFACE WATER		Assumed Value	Units	Calculated Value
Water Ingestion Rate	Recreational Fisher	0.005	(l/day)	
Skin Exposed	Recreational Fisher	5669	(cm^2)	
Body Weight	Recreational Fisher	70	(kg)	
Exposure Time	Recreational Fisher	1	(hr/day)	
Exposure Frequency	Recreational Fisher	26	(days)/365 (days) =	7.12E-02
Exposure Duration (cancer)	Recreational Fisher	30	(yrs)/ 70(yrs) =	4.29E-01
Exposure Duration (noncancer)	Recreational Fisher	30	(yrs)/ 30(yrs) =	1.00E+00
Lifetime		70	(years)	
Unit Conversion Factor		0.001	(l/cm^3)	

AECOM

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO
CARCINOGENIC ASSESSMENT
DERMAL CONTACT
WITH BROWN DITCH SURFACE WATER
RECREATIONAL FISHER

Constituent	Brown Ditch Surface Water Concentration (mg/L)	Dermal Permeability Constant (cm/hr)	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	Dermal Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	ADDing Recreational Fisher (mg/kg-day)	ADDder Recreational Fisher (mg/kg-day)	Potential Excess Lifetime Cancer Risk Ingestion	Dermal Contact	Total
Arsenic	1.22E-02	1.00E-03	1.50E+00	1.50E+00	2.66E-08	3.02E-08	3.99E-08	4.52E-08	8.51E-08
Boron	3.02E+00	1.00E-03	NA	NA	6.59E-06	7.47E-06	NA	NC	NC
Iron	2.99E+00	1.00E-03	NA	NA	6.52E-06	7.39E-06	NA	NC	NC
Molybdenum	1.31E+00	1.00E-03	NA	NA	2.86E-06	3.24E-06	NA	NC	NC
Manganese	5.71E-01	1.00E-03	NA	NA	1.25E-06	1.41E-06	NA	NC	NC
						Total:	**3.99E-08**	**4.52E-08**	**8.51E-08**

AECOM

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO
NONCARCINOGENIC ASSESSMENT
DERMAL CONTACT
WITH BROWN DITCH SURFACE WATER
RECREATIONAL FISHER

Constituent	Brown Ditch Surface Water Concentration (mg/L)	Dermal Permeability Constant (cm/hr)	Oral Reference Dose (mg/kg-day)	Dermal Reference Dose (mg/kg-day)	ADDing Recreational Fisher (mg/kg-day)	ADDder Recreational Fisher (mg/kg-day)	Potential Hazard Quotient Ingestion	Potential Hazard Quotient Dermal Contact	Potential Hazard Quotient Total
Arsenic	1.22E-02	1.00E-03	3.00E-04	3.00E-04	6.21E-08	7.04E-08	2.07E-04	2.35E-04	4.42E-04
Boron	3.02E+00	1.00E-03	2.00E-01	2.00E-01	1.54E-05	1.74E-05	7.68E-05	8.71E-05	1.64E-04
Iron	2.99E+00	1.00E-03	7.00E-01	7.00E-01	1.52E-05	1.72E-05	2.17E-05	2.46E-05	4.64E-05
Molybdenum	1.31E+00	1.00E-03	5.00E-03	5.00E-03	6.67E-06	7.56E-06	1.33E-03	1.51E-03	2.84E-03
Manganese	5.71E-01	1.00E-03	2.40E-02	9.60E-04	2.91E-06	3.29E-06	1.21E-04	3.43E-03	3.55E-03
						Total:	**1.64E-03**	**5.29E-03**	**7.05E-03**

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO

Receptors Evaluated:	
Receptor 1:	Recreational Fisher

CARCINOGENIC AND NONCARCINOGENIC ASSUMPTIONS FOR RECREATIONAL FISHER INGESTION OF BROWN DITCH FISH		**Assumed Value**	**Units**	**Calculated Value**
Fish Ingestion Rate	Recreational Fisher	0.0092	(kg fish/day)	
Body Weight	Recreational Fisher	70	(kg)	
Exposure Frequency	Recreational Fisher	365	(days)/ 365 (days) =	1.00E+00
Exposure Duration (cancer)	Recreational Fisher	30	(yrs)/ 70 (yrs) =	4.29E-01
Exposure Duration (noncancer)	Recreational Fisher	30	(yrs)/ 30 (yrs) =	1.00E+00
Lifetime		70	(years)	

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO
CARCINOGENIC ASSESSMENT
RECREATIONAL FISHER
BROWN DITCH FISH INGESTION

Constituent	Concentration In Fish Tissue (mg/kg)	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	ADDing Recreational Fisher (mg/kg-day)	Excess Lifetime Cancer Risk
Arsenic	4.22E-02	1.5	2.38E-06	3.57E-06
Manganese	2.28E+02	NA	1.29E-02	NC
Molybdenum	3.01E+00	NA	1.70E-04	NC
			Total:	3.57E-06

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO
NONCARCINOGENIC ASSESSMENT
RECREATIONAL FISHER
BROWN DITCH FISH INGESTION

AECOM

Constituent	Concentration In Fish Tissue (mg/kg)	Oral Reference Dose (mg/kg-day)	ADDing Recreational Fisher (mg/kg-day)	Hazard Index
Arsenic	4.22E-02	3.00E-04	5.55E-06	1.85E-02
Manganese	2.28E+02	2.40E-02	3.00E-02	1.25E+00
Molybdenum	3.01E+00	5.00E-03	3.96E-04	7.92E-02
			Total:	1.35E+00

Attachment E – Seep Human Health Risk Assessment

Seep Evaluation

During the period between the Remedial Investigation (RI) field investigation (2006/2007) and June 2012, two seeps were identified on the western side of Yard 520 along Birch Street. The seep that was present in April 2010 was inspected by USEPA and samples were collected by the Respondents for laboratory analysis. These results have been quantitatively evaluated, as discussed below.

The results of the April 21, 2010 suspected seep sampling were submitted to USEPA in the Progress Report for June 2010, and are shown in Table 2 from that report (included here as Attachment 1) (this table also presents the results of surface water samples that were collected at two of the RI background locations; these results are not included in this analysis). The results were used to evaluate potential risks and hazards associated with potential exposure to seep water by a recreational receptor. Note that because of the small size of the seep and the low flow of water from the seep, it was difficult to collect a sample of sufficient size for analysis. The seeps are intermittent, and are not present as of June 2012.

Assumptions

The seep evaluation was conducted following USEPA guidance and the methods used in the human health risk assessment (HHRA) for the Pines Area of Investigation. Exposure assumptions are shown on Table 1, and represent a recreational child. Because of the infrequency of the presence of a seep at Yard 520, it was assumed that a child could potentially be exposed to constituents present in the seep once per year for one hour via incidental ingestion and dermal contact.

Constituent Screen

The detected constituent concentrations in the suspected seep sample (total, not dissolved) were screened against USEPA regional screening levels (RSLs) for tapwater (May 2012). This is conservative as this is not a source of drinking water. Constituents with a detected concentration greater than the USEPA tapwater RSL value were retained as constituents of potential concern (COPCs), as shown in Table 2.

Results

As only one sample was available for analysis, the exposure point concentrations (EPCs) were equal to the maximum detected concentration for that constituent, as shown on Table 3.

Attachment 2 provides the risk calculations. The summary of potential excess lifetime cancer risk and hazard indices is presented in the table below. The total potential excess lifetime cancer risk for recreational child contact with seep water was 4.14E-09. The total hazard index was 5.29-04, with all individual hazard quotients below 1.

These results are below the target risk range of 1E-06 to 1E-04 and target hazard index of 1 and represent a conservative exposure frequency. The exposure frequency for the recreational child could be increased to one hour a day for 240 days per year for the six year exposure duration assumed for the child and the results would still be below a target risk level of 1E-06 and hazard index level of 1. This hypothetical scenario is not reasonable, but is included here for demonstration purposes, and shows that there is little if any risk that could be posed by a seep at Yard 520.

Constituent	Potential Excess Lifetime Cancer Risk	Potential Hazard Quotient
Aluminum	NC	1.31E-05
Arsenic	4.14E-09	1.07E-04
Iron	NC	7.35E-06
Manganese	NC	3.93E-05
Molybdenum	NC	2.54E-04
Selenium	NC	2.65E-06
Strontium	NC	2.75E-06
Vanadium	NC	1.03E-04
Total	**4.14E-09**	**5.29E-04**

NC – Not Calculated. Not a potential carcinogen.

Tables

TABLE 1
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - RECREATIONAL CHILD SEEP EVALUATION

Parameter	RME Child (0 to 6 yrs)	
Parameters Used in the Seep Water Scenario		
Exposure Time (hr/event)	1	(a)
Exposure Frequency (days/year)	1	(a)
Exposure Duration (yr)	6	(b)
Water Ingestion Rate (l/event)	0.005	(c)
Skin Contacting Medium (cm^2)	2800	(d)
Body Weight (kg)	15	(b)

Notes:
RME - Reasonable Maximum Exposure.
(a) - It is assumed that a seep may occur once per year and that a child is potentially exposed for one hour.
(b) - USEPA, 1991a. Standard Default Exposure Factors.
(c) - USEPA, 1989a. 1/10th of the ingestion rate for swimming presented in Risk Assessment Guidance for Superfund, Volume I.
(d) - USEPA, 1997a. Exposure Factors Handbook. Represents average 50th percentile surface area for males and females of head, hands, forearms, lower legs, and feet.

TABLE 2
SELECTION OF CONSTITUENTS OF POTENTIAL CONCERN - SEEP WATER
PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT

AECOM

Constituent	Detected Concentration (ug/L)	Tapwater Screening Level (a) (ug/L)	Basis	Maximum Contaminant Level (b) (ug/L)	Is Detected Concentration >RSL?	COPC?	Reason
ALUMINUM	9220	1600	NC	--	Yes	Yes	Detected Concentration > RSL
ARSENIC	22.6	0.045	C	10	Yes	Yes	Detected Concentration > RSL
BARIUM	127	290	NC	2000	No	No	Detected Concentration < RSL
BORON	308	310	NC	--	No	No	Detected Concentration < RSL
CALCIUM	156000	EN		--	--	No	EN
IRON	3610	1100	NC	--	Yes	Yes	Detected Concentration > RSL
MAGNESIUM	1160	EN		--	--	No	EN
MANGANESE	68.9	32	NC	--	Yes	Yes	Detected Concentration > RSL
MERCURY	0.231	0.43	NC	2	No	No	Detected Concentration < RSL
MOLYBDENUM	893	7.8	NC	--	Yes	Yes	Detected Concentration > RSL
POTASSIUM	92300	EN		--	--	No	EN
SELENIUM	9.3	7.8	NC	50	Yes	Yes	Detected Concentration > RSL
SILICON	10400	NA		--	--	No	No RSL or dose-response value available.
SODIUM	250000	EN		--	--	No	EN
STRONTIUM	1160	930	NC	--	Yes	Yes	Detected Concentration > RSL
VANADIUM	25.1	7.8	NC	--	Yes	Yes	Detected Concentration > RSL

Notes:
C - RSL is based on potentially carcinogenic effects.
COPC - Constituent of Potential Concern.
EN - Essential Nutrient.
MCL - Maximum Contaminant Level.
NA - Not Available. No dose-response values available to calculate RSL.
NC - RSL is based on noncarcinogenic effects.
RSL - Regional Screening Level.
USEPA - United States Environmental Protection Agency.
(a) - Regional Screening Levels for Chemical Contaminants at Superfund Sites. May 2012. http://www.epa.gov/region09/superfund/prg/index.html. Values for tapwater.
If RSL is based on a noncancer endpoint, the RSL is adjusted to a hazard quotient of 0.1 by multiplying the RSL by 0.1. The risk level is 1E-6 if the RSL is based on a cancer endpoint.
(b) - USEPA Maximum Contaminant Level. 2012 Edition of the Drinking Water Standards and Health Advisories.
(c) - The 16 metals analyzed were all reported as detected.

TABLE 3
SEEP EXPOSURE POINT CONCENTRATIONS
PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT

Constituent	EPC (a) (mg/L)
Aluminum	9.22E+00
Arsenic	2.26E-02
Iron	3.61E+00
Manganese	6.89E-02
Molybdenum	8.93E-01
Selenium	9.30E-03
Strontium	1.16E+00
Vanadium	2.51E-02

Notes:
EPC - Exposure Point Concentration.
(a) - One sample available. Detected concentration selected as EPC.

Attachment 1

USEPA Progress Report for June 2010 Table 2

TABLE 2
VALIDATED SUSPECTED SEEP SAMPLING ANALYTICAL RESULTS
FOR SAMPLES COLLECTED IN APRIL 2010
PINES AREA OF INVESTIGATION
PROGRESS REPORT -- JUNE 2010

		Location ID	SUSPECTED SEEP	SUSPECTED SEEP	SW001	SW001	SW002	SW002
		Sample Date	4/21/2010	4/21/2010	4/21/2010	4/21/2010	4/21/2010	4/21/2010
		Sample ID	SEEPXS042110S	SEEPXS042110SF	SW001XSW042110S	SW001XSW042110SF	SW002XSW042110S	SW002XSW042110SF
		Fraction	Total	Dissolved	Total	Dissolved	Total	Dissolved
		Sample Matrix	Suspected Seep	Suspected Seep	Surface Water	Surface Water	Surface Water	Surface Water
		Sample Type	Sample	Sample	Sample	Sample	Sample	Sample
CAS Number	**Chemical Name**	**Unit**						
Other Inorganic Parameters								
ALK	ALKALINITY, TOTAL (AS CACO3)	mg/l	415	--	161	--	167	--
ALKB	ALKALINITY (BICARBONATE)	mg/l	2.0 U	--	161	--	167	--
ALKC	ALKALINITY (CARBONATE)	mg/l	412	--	2.0 U	--	2.0 U	--
7664-41-7	AMMONIA	mg/l	14.8	--	0.050 U	--	0.050 U	--
16887-00-6	CHLORIDE	mg/l	224	--	47.9	--	16.5	--
14797-55-8	NITRATE AS NITROGEN	mg/l	0.50 U	--	0.50 U	--	0.50 U	--
14265-44-2	ORTHOPHOSPHATE AS PHOSPHATE	mg/l	0.010 U	--	0.0247	--	0.0763	--
14808-79-8	SULFATE	mg/l	10.5	--	14.1	--	17.7	--
TSS	TOTAL SUSPENDED SOLIDS	mg/l	1100	--	216	--	3.6	--
Metals								
7429-90-5	ALUMINUM	ug/l	9220	2370	170	17.2 J	221	15.2 J
7440-38-2	ARSENIC	ug/l	22.6	21.3	10.0 U	10.0 U	10.0 U	10.0 U
7440-39-3	BARIUM	ug/l	127	68.5	90.3	84.4	28.0	25.5
7440-42-8	BORON	ug/l	308 J-	--	137 J-	--	42.9 J-	--
7440-70-2	CALCIUM	ug/l	156000	80700	39400	38600	43800	43700
7439-89-6	IRON	ug/l	3610	100 U	1780	828	1510	508
7439-95-4	MAGNESIUM	ug/l	1160	1000 U	16300	16100	18600	18600
7439-96-5	MANGANESE	ug/l	68.9	10.0 U	91.6	75.4	133	132
7439-97-6	MERCURY	ug/l	0.231	0.151 J	0.200 UJ	0.200 UJ	0.200 UJ	0.200 UJ
7439-98-7	MOLYBDENUM	ug/l	893	931	10.0 U	10.0 U	10.0 U	10.0 U
7440-09-7	POTASSIUM	ug/l	92300	84300	1700 J	1610 J	2250	2210
7782-49-2	SELENIUM	ug/l	9.3 J	10.0 U	10.0 U	9.5 J	10.0 U	10.0 U
7440-21-3	SILICON	ug/l	10400 J-	4470 J-	4060 J-	3690 J-	2430 J-	2020 J-
7440-23-5	SODIUM	ug/l	250000	245000	39600	38500	10400	10200
7440-24-6	STRONTIUM	ug/l	1160	864	476	462	106	105
7440-62-2	VANADIUM	ug/l	25.1 J	18.1 J	50.0 U	50.0 U	50.0 U	50.0 U

Notes:
CAS - Chemical Abstract Service
ID - Identifier
mg/L - milligrams per liter
ug/L - micrograms per liter
U - The analyte was analyzed for, but was not detected above the sample reporting limit
J - The result is an estimated quantity; the associated numerical value is the approximate concentration of the analyhte in the sample
J- - The result is an estimated quantity, but the result may be biased low

Attachment 2

Risk Calculation Spreadsheets

AECOM

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO

Receptors Evaluated:	
Receptor 1:	Recreational Child

CARCINOGENIC AND NONCARCINOGENIC ASSUMPTIONS FOR RECREATIONAL CHILD CONTACT WITH SEEP WATER		Assumed Value	Units	Calculated Value
Water Ingestion Rate	Recreational Child	0.005	(l/day)	
Skin Exposed	Recreational Child	2800	(cm^2)	
Body Weight	Recreational Child	15	(kg)	
Exposure Time	Recreational Child	1	(hr/day)	
Exposure Frequency	Recreational Child	1	(days)/365 (days) =	2.74E-03
Exposure Duration (cancer)	Recreational Child	6	(yrs)/ 70(yrs) =	8.57E-02
Exposure Duration (noncancer)	Recreational Child	6	(yrs)/ 6(yrs) =	1.00E+00
Lifetime		70	(years)	
Unit Conversion Factor		0.001	(l/cm^3)	

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO
CARCINOGENIC ASSESSMENT
CONTACT WITH
SEEP WATER
RECREATIONAL CHILD

Constituent	Seep Surface Water Concentration (mg/L)	Dermal Permeability Constant (cm/hr)	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	Dermal Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	ADDing Recreational Child (mg/kg-day)	ADDder Recreational Child (mg/kg-day)	Potential Excess Lifetime Cancer Risk Ingestion	Dermal Contact	Total
Aluminum	9.22E+00	1.00E-03	NA	NA	7.22E-07	4.04E-07	NC	NC	NC
Arsenic	2.26E-02	1.00E-03	1.50E+00	1.50E+00	1.77E-09	9.91E-10	2.65E-09	1.49E-09	4.14E-09
Iron	3.61E+00	1.00E-03	NA	NA	2.83E-07	1.58E-07	NC	NC	NC
Manganese	6.89E-02	1.00E-03	NA	NA	5.39E-09	3.02E-09	NC	NC	NC
Molybdenum	8.93E-01	1.00E-03	NA	NA	6.99E-08	3.91E-08	NC	NC	NC
Selenium	9.30E-03	1.00E-03	NA	NA	7.28E-10	4.08E-10	NC	NC	NC
Strontium	1.16E+00	1.00E-03	NA	NA	9.08E-08	5.08E-08	NC	NC	NC
Vanadium	2.51E-02	1.00E-03	NA	NA	1.96E-09	1.10E-09	NC	NC	NC
						Total:	**2.65E-09**	**1.49E-09**	**4.14E-09**

PINES AREA OF INVESTIGATION
HUMAN HEALTH RISK ASSESSMENT
REASONABLE MAXIMUM EXPOSURE SCENARIO
NONCARCINOGENIC ASSESSMENT
CONTACT WITH
SEEP WATER
RECREATIONAL CHILD

Constituent	Seep Surface Water Concentration (mg/L)	Dermal Permeability Constant (cm/hr)	Oral Reference Dose (mg/kg-day)	Dermal Reference Dose (mg/kg-day)	ADDing Recreational Child (mg/kg-day)	ADDder Recreational Child (mg/kg-day)	Potential Hazard Quotient Ingestion	Potential Hazard Quotient Dermal Contact	Total
Aluminum	9.22E+00	1.00E-03	1.00E+00	1.00E+00	8.42E-06	4.72E-06	8.42E-06	4.72E-06	1.31E-05
Arsenic	2.26E-02	1.00E-03	3.00E-04	3.00E-04	2.06E-08	1.16E-08	6.88E-05	3.85E-05	1.07E-04
Iron	3.61E+00	1.00E-03	7.00E-01	7.00E-01	3.30E-06	1.85E-06	4.71E-06	2.64E-06	7.35E-06
Manganese	6.89E-02	1.00E-03	2.40E-02	9.60E-04	6.29E-08	3.52E-08	2.62E-06	3.67E-05	3.93E-05
Molybdenum	8.93E-01	1.00E-03	5.00E-03	5.00E-03	8.16E-07	4.57E-07	1.63E-04	9.13E-05	2.54E-04
Selenium	9.30E-03	1.00E-03	5.00E-03	5.00E-03	8.49E-09	4.76E-09	1.70E-06	9.51E-07	2.65E-06
Strontium	1.16E+00	1.00E-03	6.00E-01	6.00E-01	1.06E-06	5.93E-07	1.77E-06	9.89E-07	2.75E-06
Vanadium	2.51E-02	1.00E-03	5.04E-03	1.31E-04	2.29E-08	1.28E-08	4.55E-06	9.80E-05	1.03E-04
						Total:	**2.56E-04**	**2.74E-04**	**5.29E-04**